

PROPOSED CHANGES FOR 120 DAY REVIEW

**PROPOSED CHANGES AS ACCEPTED BY THE SEPTEMBER 2002
REVIEW PANEL MEETING FOR 120 DAY REVIEW BY MEMBER STATES
AND INTERNATIONAL ORGANIZATIONS**

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SUMMARY

The proposed changes, as accepted by the September 2002 Review Panel meeting and endorsed by the February 2003 TRANSSC meeting for the 120 day review by Member States and International Organizations, are presented in this report in Tables and Appendices. Table 1 provides details on the accepted changes which are presented according to the paragraph order in the current regulations (TS-R-1). Table 2 provides a cross reference table where the accepted changes are also listed alphabetically in country order to facilitate checking which proposals have been accepted and what proposed change numbers have been assigned.

Please note that the Review Panel did not fully support proposed changes #9, # 16, #46 and #58.

There are 3 appendices to this report. The contents of these appendices are outlined following the further information on the tables.

TABLES

TABLE 1

The table contains the following 5 columns:

Column 1 provides the assigned change number.

The assigned change number is required for the further review process. In all correspondence regarding changes it is this number which should be used from this point forward. So, where comments are made during the 120-day review period they should refer to this change number. When referencing the change in comments this number should be given exactly as it is, (for example change #1 should be called “1” not “01” or “#1”).

Column 2 provides the original proposal number.

In some cases there are related proposals for the same or a similar change to a paragraph. These related proposals are listed together in column 2. For example, change #16 concerning paragraph 416. The accepted proposal is identified as UK/02/52. The related proposals, Canada/02/02, UK/02/48 and UK/02/49 are identified together with UK/02/52. This was done in order to recognize that they were also considered by the Review Panel and because the justification and explanation provided in these related proposals are also relevant for the review of the accepted text of the proposed change (which may be

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different from the originally proposed text in any of these proposals). Related proposals that were rejected by the Review Panel are not included.

In other cases there could be alternate proposals for the same intended change but the Review Panel did not decide on the preferred alternative. The 120 day review should help to identify the preferred option. For example, change #24 and #25.

In still other cases there are proposals concerning unrelated changes to the same paragraph. In those cases the accepted changes are listed as separate changes for the same paragraph. For example, changes #27, #31, #32 and #33 all concern changes to paragraph 672. Actually because there were so many proposals for different aspects of this rather lengthy paragraph these four changes were combined in Appendix 2 for easier review of the result if all these changes were eventually approved.

Sometimes a proposal number is split up in different parts. For example, Canada/02/12 is split up in 6 parts (changes #6, #7, #8, #42, #53 and # 56). This was done because as a result of accepting change #6 concerning paragraph 230, there are related changes to other paragraphs. If the changes to these other paragraphs do not involve other relevant proposals for these other paragraphs then the related parts are listed following the original proposal (for example #7 and #8). If the changes to these other paragraphs should be considered together with other proposals for these other paragraphs then the parts are listed with the other related proposals for these other paragraphs. For example, change #42 (Canada/02/12 (4 of 6) which relates to paragraph 805 needs to be considered together with changes #43 (UK/02/39 (1 of 4) and change #44 (UK/02/40) which are also concerned with paragraph 805). The main proposal number of the split proposals is needed to be able to review the related justification and explanation. In these cases the main proposal number is added in italics in the proposal column (column 2).

Column 3 provides the number of the affected paragraph of the regulations.

Proposed changes to Tables are listed where the Tables occur in the paragraph sequence. Where the change involves only consequential changes, for example change #5 involving consequential changes to paragraphs 226, 418 etc. provides first a reference to the change (paragraph 222) that is causing the consequential changes. This is important in case the original change is not accepted or modified during the further review process.

Column 4 provides the existing text in TS-R-1 for the paragraph for which a change is recommended.

If in this column a part of the paragraph is marked in **bold** then the proposal involves deleting the bold part of the existing text.

Column 5 provides the proposed new text as accepted by the Review Panel.

Any part in **bold** in this column indicates where the text is new or revised.

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TABLE 2

A cross reference table is provided, giving the accepted changes in country order. This country order is provided to facilitate checking which proposals have been accepted for further review and to identify the related proposed change numbers.

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APPENDICES

APPENDIX 1

Appendix 1 provides the details of Change #5 which is a substantial number of consequential changes if Change #4 is accepted.

APPENDIX 2

Appendix 2 provides a consolidated version of changes #27, #31, #32 and #33 to facilitate review of the separate proposed changes for the same lengthy paragraph. It should be noted that there is another proposed change (#37) related to the same paragraph which could not be merged into the consolidated paragraph and which was not considered complete by the Review Panel. In addition, Changes #28/30 and #34/36 are related consequential changes.

APPENDIX 3

Appendix 3 provides in detail proposed change #51 concerning paragraphs 815/818 TRANSITIONAL ARRANGEMENTS (Grandfathering arrangements). The detail also includes the justification/explanation. It should be noted that there are some other proposals (# 48/50) on specific aspects of these paragraphs.

NOTE. The use of **bold** text in the current and new text in Appendix 3 is not as it is in TABLE 1, columns 3 and 4. Instead it is reflecting the use of bold text in the current regulations.

APPENDIX 4

Appendix 4 provides in detail proposed change #61 concerning radiation protection issues in Table form. The full text of section III of the Regulations is included to demonstrate how the change looks in context. The text also includes draft advisory and explanatory material at the end of the appendix.

APPENDIX 5

Appendix 5 is a draft report submitted by the US that discusses risk-informed limits for non-fixed surface contamination on spent fuel transportation casks. This documents provides the basis for proposed change #63 concerning contamination.

TABLE 1

**DETAILS OF ACCEPTED CHANGES
IN PARAGRAPH ORDER**

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
1	UK/02/04	204	204. <i>Multilateral approval</i> shall mean approval by the relevant <i>competent authority</i> both of the country of origin of the <i>design</i> or <i>shipment</i> and of each country through or into which the <i>consignment</i> is to be transported. The term “through or into” specifically excludes “over”, i.e. the approval and notification requirements shall not apply to a country over which <i>radioactive material</i> is carried in an <i>aircraft</i> , provided that there is no scheduled stop in that country.	204. <i>Multilateral approval</i> shall mean approval by the relevant <i>competent authority</i> of the country of origin of the <i>design</i> or <i>shipment</i> and also, where the design or shipment is to be transported through or into any other country, approval by the competent authority of that country. The term “through or into” - specifically excludes “over”, i.e. the approval and notification requirements shall not apply to a country over which <i>radioactive material</i> is carried in an <i>aircraft</i> , provided that there is no scheduled stop in that country.
2	UK/02/05	204	204. <i>Multilateral approval</i> shall mean approval by the relevant <i>competent authority</i> both of the country of origin of the <i>design</i> or <i>shipment</i> and of each country through or into which the <i>consignment</i> is to be transported. The term “through or into” specifically excludes “over”, i.e. the approval and notification requirements shall not apply to a country over which <i>radioactive material</i> is carried in an <i>aircraft</i> , provided that there is no scheduled stop in that country.	204. <i>Multilateral approval</i> shall mean approval by the relevant <i>competent authority</i> both of the country of origin of the <i>design</i> or <i>shipment</i> and of each country through or into which the <i>consignment</i> is to be transported. The term “through or into” specifically excludes “over”, i.e. the approval requirements shall not apply to a country over which <i>radioactive material</i> is carried in an <i>aircraft</i> , provided that there is no scheduled stop in that country.
3	Canada/02/08	212	212. <i>Consignor</i> shall mean any person, organization or government which prepares a <i>consignment</i> for transport, and is named as consignator in the transport documents.	212. <i>Consignor</i> shall mean any person, organization or government which prepares a <i>consignment</i> for transport.

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
4	Sweden/02/02 (1 of 2) and France/02/06	222	<p>222. <i>Fissile material</i> shall mean uranium-233, uranium-235, plutonium-239, plutonium-241, or any combination of these radionuclides. Excepted from this definition is:</p> <p>(a) <i>natural uranium</i> or <i>depleted uranium</i> which is unirradiated, and</p> <p>(b) <i>natural uranium</i> or <i>depleted uranium</i> which has been irradiated in thermal reactors only.</p>	<p>222. <i>Fissile material</i> shall mean the fissile nuclides uranium-233, uranium-235, plutonium-239 or plutonium-241, contained in any material. Excepted from this definition is:</p> <p>(a) <i>natural uranium</i> or <i>depleted uranium</i> which is unirradiated, and</p> <p>(b) <i>natural uranium</i> or <i>depleted uranium</i> which has been irradiated in thermal reactors only.</p>
5	Sweden/02/02 (2 of 2) <i>see #4</i>	222 (Sweden/02/02) related consequential changes in paras 226, 418, 543, 549, 559, 672, 831, 832, 833 and Table XII		See Appendix 1
6	Canada/02/12 (1 of 6)	230	<p>230. <i>Package</i> shall mean the <i>packaging</i> with its <i>radioactive contents</i> as presented for transport. The types of <i>packages</i> covered by these Regulations, which are subject to the activity limits and material restrictions of Section IV and meet the corresponding requirements, are:</p> <p>(a) <i>Excepted package</i>;</p> <p>(b) <i>Industrial package Type 1 (Type IP-1)</i>;</p> <p>(c) <i>Industrial package Type 2 (Type IP-2)</i>;</p>	<p>230. <i>Package</i> shall mean the <i>packaging</i> with its <i>radioactive contents</i> as presented for transport. The types of <i>packages</i> covered by these Regulations, which are subject to the activity limits and material restrictions of Section IV and meet the corresponding requirements, are:</p> <p>(a) <i>Excepted package</i>;</p> <p>(b) <i>Industrial package Type 1 (Type IP-1)</i>;</p> <p>(c) <i>Industrial package Type 2 (Type IP-2)</i>;</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
7	Canada/02/12 (2 of 6) see #6	230 (Canada/02/12) related change in 538	<p>(d) <i>Industrial package Type 3 (Type IP-3);</i></p> <p>(e) <i>Type A package;</i></p> <p>(f) <i>Type B(U) package;</i></p> <p>(g) <i>Type B(M) package;</i></p> <p>(h) <i>Type C package.</i></p> <p><i>Packages containing fissile material or uranium hexafluoride are subject to additional requirements.</i></p>	<p>(d) <i>Industrial package Type 3 (Type IP-3);</i></p> <p>(e) <i>Type A package;</i></p> <p>(f) <i>Type B(U) package;</i></p> <p>(g) <i>Type B(M) package;</i></p> <p>(h) <i>Type C package;</i></p> <p>(i) Type H(U) package;</p> <p>(j) Type H(M) package.</p> <p><i>Packages containing fissile material or uranium hexafluoride are subject to additional requirements.</i></p>
			<p>538. Each <i>package</i> which conforms to a <i>design</i> approved under paras 805–814 or 816–817 shall be legibly and durably marked on the outside of the <i>packaging</i> with:</p> <p>(a) The identification mark allocated to that <i>design</i> by the <i>competent authority</i>;</p> <p>(b) A serial number to uniquely identify each <i>packaging</i> which conforms to that <i>design</i>;</p> <p>(c) In the case of a <i>Type B(U)</i> or <i>Type B(M) package design</i>, with “TYPE B(U)” or “TYPE B(M)”; and</p> <p>(d) In the case of a <i>Type C package design</i>, with “TYPE C”.</p>	<p>(possibly needed)</p> <p>538. Each <i>package</i> which conforms to a <i>design</i> approved under paras 805–814 or 816–817 shall be legibly and durably marked on the outside of the <i>packaging</i> with:</p> <p>(a) The identification mark allocated to that <i>design</i> by the <i>competent authority</i>;</p> <p>(b) A serial number to uniquely identify each <i>packaging</i> which conforms to that <i>design</i>;</p> <p>(c) In the case of a <i>Type B(U)</i> or <i>Type B(M) package design</i>, with “TYPE B(U)” or “TYPE B(M)”; or</p> <p>(c bis) In the case of a <i>Type H(U)</i> or <i>Type H(M) design</i>, with “TYPE H(U)” or “TYPE H(M)” unless under these regulations another certification type</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII mark is applicable; and
8	Canada/02/12 (3 of 6) see #6	230 (Canada/02/12) related change in 539	539. Each <i>package</i> which conforms to a <i>Type B(U)</i> , <i>Type B(M)</i> or <i>Type C package design</i> shall have the outside of the outermost receptacle which is resistant to the effects of fire and water plainly marked by embossing, stamping or other means resistant to the effects of fire and water with the trefoil symbol shown in Fig. 1.	(d) In the case of a <i>Type C package design</i> , with "TYPE C". 539. Each <i>package</i> which conforms to a <i>Type H(U)</i> , <i>Type H(M)</i> , <i>Type B(U)</i> , <i>Type B(M)</i> or <i>Type C package design</i> shall have the outside of the outermost receptacle which is resistant to the effects of fire and water plainly marked by embossing, stamping or other means resistant to the effects of fire and water with the trefoil symbol shown in Fig. 1.
9	UK/02/13	246	246. <i>Natural uranium</i> shall mean chemically separated uranium containing the naturally occurring distribution of uranium isotopes (approximately 99.28% uranium-238, and 0.72% uranium-235 by mass). <i>Depleted uranium</i> shall mean uranium containing a lesser mass percentage of uranium-235 than in <i>natural uranium</i> . <i>Enriched uranium</i> shall mean uranium containing a greater mass percentage of - uranium-235 than 0.72%. In all cases, a very small mass percentage of uranium-234 is present.	246. <i>Natural uranium</i> shall mean chemically separated uranium containing the naturally occurring distribution of uranium isotopes (approximately 99.28% uranium-238, and 0.72% uranium-235 by mass). <i>Depleted uranium</i> shall mean uranium containing a lesser mass percentage of uranium-235 than in <i>natural uranium</i> . <i>Enriched uranium</i> shall mean uranium containing a greater mass percentage of - uranium-235 than 0.72%. NOTE. Deleted sentence moved to TS-G 1.1
10	USA/02/07	303	303. Workers shall receive appropriate training concerning the radiation hazards involved and the precautions to be observed in order to ensure restriction of their exposure and that of other persons who might be affected by their actions.	303. Workers shall receive appropriate training concerning the radiation involved and the precautions to be observed in order to control their occupational exposure and that of other persons who might be affected by their actions.

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII										
11	UK/02/14	305	<p>305. For occupational exposures arising from transport activities, where it is assessed that the effective dose:</p> <p>(a) is most unlikely to exceed 1 mSv in a year, neither special work patterns nor detailed monitoring nor dose assessment programmes nor individual record keeping shall be required;</p> <p>(b) is likely to be between 1 and 6 mSv in a year, a dose assessment programme via work place monitoring or individual monitoring shall be conducted;</p> <p>(c) is likely to exceed 6 mSv in a year, individual monitoring shall be conducted.</p> <p>When individual monitoring or work place monitoring is conducted, appropriate records shall be kept.</p>	<p>305. For occupational exposures arising from transport activities, where it is assessed that the effective dose:</p> <p>(a) is likely to be between 1 and 6 mSv in a year, a dose assessment programme via work place monitoring or individual monitoring shall be conducted;</p> <p>(b) is likely to exceed 6 mSv in a year, individual monitoring shall be conducted.</p> <p>When individual monitoring or work place monitoring is conducted, appropriate records shall be kept.</p>										
12	UK/02/18	Table I footnote (a)	<p>(a) A₁ and/or A₂ values for these parent radionuclides include contributions from daughter radionuclides with half-lives less than 10 days.</p>	<p>(a) A₁ and/or A₂ values for these parent radionuclides include contributions from daughter radionuclides with half-lives less than 10 days, as listed in the following:</p> <table style="margin-left: 40px;"> <tr> <td>Mg 28</td> <td>Al 28</td> </tr> <tr> <td>Ar 42</td> <td>K 42</td> </tr> <tr> <td>Ca 47</td> <td>Sc 47</td> </tr> <tr> <td>Ti 44</td> <td>Sc 44</td> </tr> <tr> <td>Fe 52</td> <td>Mn 52m</td> </tr> </table>	Mg 28	Al 28	Ar 42	K 42	Ca 47	Sc 47	Ti 44	Sc 44	Fe 52	Mn 52m
Mg 28	Al 28													
Ar 42	K 42													
Ca 47	Sc 47													
Ti 44	Sc 44													
Fe 52	Mn 52m													

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
				Fe 60 Zn 69m Ge 68 Rb 83 Sr 82 Sr 90 Sr 91 Sr 92 Y 87 Zr 95 Zr 97 Mo 99 Tc 95m Tc 96m Ru 103 Ru 106 Pd 103 Ag 108m Ag 110m Cd 115 In 114m Sn 113 Sn 121m Sn 126 Te 118 Te 127m Te 129m Te 131m Te 132 I 135 Xe 122 Cs 137 Ba 131 Ba 140 Ce 144 Pm 148m Gd 146 Dy 166 Co 60m Zn 69 Ga 68 Kr 83m Rb 82 Y 90 Y 91m Y 92 Sr 87m Nb 95m Nb 97m, Nb 97 Tc 99m Tc 95 Tc 96 Rh 103m Rh 106 Rh 103m Ag 108 Ag 110 In 115m In 114 In 113m Sn 121 Sb 126m Sb 118 Te 127 Te 129 Te 131 I 132 Xe 135m I 122 Ba 137m Cs 131 La 140 Pr 144m, Pr 144 Pm 148 Eu 146 Ho 166

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
				Hf 172 Lu 172 W 178 Ta 178 Re 188 Os 189m Os 194 Ir 189 Os 189m Ir 188 Au 194 Hg 194 Hg 195m Hg 195 Pb 210 Bi 210 Pb 212 Bi 212, Tl 208, Po 212 Tl 206 Tl 208, Po 212 Po 211 At 211 Rn 222 Po 218, Pb 214, At 218, Bi 214, Po 214 Rn 219, Po 215, Pb 211, Bi 211, Po 211, Tl 207 Ra 223 Ra 224 Rn 220, Po 216, Pb 212, Bi 212, Tl 208, Po 212 Ac 225, Fr 221, At 217, Bi 213, Tl 209, Po 213, Pb 209 Ra 226 Rn 222, Po 218, Pb 214, At 218, Bi 214, Po 214 Ra 228 Ac 228 Fr 221, At 217, Bi 213, Tl 209, Po 213, Pb 209 Ac 227 Fr 223 Th 228 Ra 224, Rn 220, Po 216, Pb 212, Bi 212, Tl 208, Po 212 Th 234 Pa 230 Pa 234m, Pa 234 Ac 226, Th 226, Fr 222, Ra 222, Rn 218, Po 214 U 230 Th 226, Ra 222, Rn 218, Po 214 U 235 Th 231 Pu 241 U 237 Pu 244 U 240, Np 240m Am 242m Am 242, Np 238 Np 239

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
13	Germany/02/06	Table I footnote (b)	<p>(b) Parent nuclides and their progeny included in secular equilibrium are listed in the following:</p> <p>Sr-90 Y-90 Zr-93 Nb-93m Zr-97 Nb-97 Rh-106 Ru-106 Cs-137 Ba-137m Ce-134 La-134 Pr-144 Ce-144 Ba-140 La-140 Bi-212 Tl-208 (0.36), Po-212 (0.64) Pb-210 Bi-210, Po-210 Pb-212 Bi-212, Tl-208 (0.36), Po-212 (0.64) Rn-220 Po-216 Rn-222 Po-218, Pb-214, Bi-214, Po-214 Rn-222 Po-218, Pb-214, Bi-214, Po-214 Ra-223 Rn-219, Po-215, Pb-211, Bi-211, Tl-207 Ra-224 Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64) Ra-226 Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210 Ac-228 Th-226 Ra-222, Rn-218, Po-214 Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64) Th-228 Th-229 Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209 Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)</p>	<p>(b) Parent nuclides and their progeny included in secular equilibrium are listed in the following:</p> <p>Sr-90 Y-90 Zr-93 Nb-93m Zr-97 Nb-97 Rh-106 Ru-106 Ag-108m Ag-108 Cs-137 Ba-137m Ce-144 Pr-144 Ba-140 La-140 Bi-212 Tl-208 (0.36), Po-212 (0.64) Pb-210 Bi-210, Po-210 Pb-212 Bi-212, Tl-208 (0.36), Po-212 (0.64) Rn-222 Po-218, Pb-214, Bi-214, Po-214 Ra-223 Rn-219, Po-215, Pb-211, Bi-211, Tl-207 Ra-224 Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64) Ra-226 Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210 Ac-228 Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64) Th-228 Th-229 Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209 Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64) Th-nat Th-234 Th-234m U-230 Th-226, Ra-222, Rn-218, Po-214</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
14	UK/02/15	402	<p>Th-234 Pa-234m U-230 Th-226, Ra-222, Rn-218, Po-214 U-232 Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64) U-235 Th-231 Th-234, Pa-234m Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210 U-240 Np-237 Pa-233 Am-242m Am-243 Np-239</p>	<p>U-232 Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64) Th-231 U-235 Th-234, Pa-234m Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210 Np-237 Pa-233 Am-242m Am-243 Np-239</p>
15	Japan/02/02	TABLE II (first column)	<p>402. For individual radionuclides which are not listed in Table I the determination of the basic radionuclide values referred to in para. 401 shall require <i>competent authority approval</i> or, for international transport, <i>multilateral approval</i>. Where the chemical form of each radionuclide is known, it is permissible to use the A_2 value related to its solubility class as recommended by the International Commission on Radiological Protection, if the chemical forms under both normal and accident conditions of transport are taken into consideration. Alternatively, the radionuclide values in Table II may be used without obtaining <i>competent authority approval</i>.</p>	<p>402. For individual radionuclides which are not listed in Table I the determination of the basic radionuclide values referred to in para. 401 shall require <i>multilateral approval</i>. It is permissible to use an A_2 value calculated using a dose coefficient for the appropriate lung absorption type, as recommended by the International Commission on Radiological Protection, if the chemical forms of each radionuclide under both normal and accident conditions of transport are taken into consideration. Alternatively, the radionuclide values in Table II may be used without obtaining <i>competent authority approval</i>.</p>

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16	UK/02/52 and Canada/02/02, UK/02/48, UK/02/49	416	<p>Only beta or gamma emitting nuclides are known to be present</p> <p>Only alpha emitting nuclides are known to be present</p> <p>No relevant data are available</p> <p>416. <i>Type B(U) and Type B(M) packages</i>, if transported by air, shall meet the requirements of para. 415 and shall not contain activities greater than the following:</p> <p>(a) for <i>low dispersible radioactive material</i> — as authorized for the <i>package design</i> as specified in the certificate of approval,</p> <p>(b) for <i>special form radioactive material</i> — 3000 A_1 or 100 000 A_2, whichever is the lower; or</p> <p>(c) for all other <i>radioactive material</i> — 3000 A_2.</p>	<p>Only beta or gamma emitting nuclides are known to be present</p> <p>Alpha emitting nuclides without emitting neutrons in greater than 10^{-2} of their decays are known to be present</p> <p>No relevant data are available</p> <p>416. <i>Type B(U) and Type B(M) packages</i>, if transported by air, shall meet the requirements of para. 415 and shall not contain activities greater than the following:</p> <p>(a) for <i>low dispersible radioactive material</i> — as authorized for the <i>package design</i> as specified in the certificate of approval;</p> <p>(b) for Co-60 as special form—30000 A_1 ;</p> <p>(c) for other special form radioactive material — 3000 A_1 or 100 000 A_2, whichever is the lower; or</p> <p>(d) for all other <i>radioactive material</i> — 3000 A_2.</p>
17	UK/02/19	419	<p>419. The mass of uranium hexafluoride in a <i>package</i> shall not exceed a value that would lead to an ullage smaller than 5% at the maximum temperature of the <i>package</i> as specified for the plant systems where the <i>package</i> shall be used. The uranium hexafluoride shall be in solid form and the</p>	<p>419. The mass of uranium hexafluoride in a <i>package</i> shall be within limits set in the certificate of approval, and shall not exceed a value that would lead to an ullage smaller than 5% at the maximum temperature of the <i>package</i> as specified for the plant systems where the <i>package</i> shall be used. The uranium</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
18	France/02/22	502	<p>internal pressure of the <i>package</i> shall be below atmospheric pressure when presented for transport.</p> <p>502. Before each <i>shipment</i> of any <i>package</i>, the following requirements shall be fulfilled:</p> <p>(a) For any <i>package</i> it shall be ensured that all the requirements specified in the relevant provisions of these Regulations have been satisfied.</p> <p>(b) It shall be ensured that lifting attachments which do not meet the requirements of para. 607 have been removed or otherwise rendered incapable of being used for lifting the <i>package</i>, in accordance with para. 608.</p> <p>(c) For each <i>Type B(U)</i>, <i>Type B(M)</i> and <i>Type C package</i> and for each <i>package</i> - containing <i>fissile material</i>, it shall be ensured that all the requirements specified in the approval certificates have been satisfied.</p> <p>(d) Each <i>Type B(U)</i>, <i>Type B(M)</i> and <i>Type C package</i> shall be held until equilibrium conditions have been approached closely enough to demonstrate compliance with the requirements for temperature and pressure unless an exemption from these</p>	<p>hexafluoride shall be in solid form and the internal pressure of the <i>package</i> shall be below atmospheric pressure when presented for transport.</p> <p>502. Before each <i>shipment</i> of any <i>package</i>, the following requirements shall be fulfilled:</p> <p>(a) For any <i>package</i> it shall be ensured that all the requirements specified in the relevant provisions of these Regulations have been satisfied.</p> <p>(b) It shall be ensured that lifting attachments which do not meet the requirements of para. 607 have been removed or otherwise rendered incapable of being used for lifting the <i>package</i>, in accordance with para. 608.</p> <p>(c) For each <i>Type B(U)</i>, <i>Type B(M)</i> and <i>Type C package</i> and for each <i>package</i> - containing <i>fissile material</i>, or 0.1 kg or more of uranium hexafluoride, it shall be ensured that all the requirements - specified in the approval certificates have been satisfied.</p> <p>(d) Each <i>Type B(U)</i>, <i>Type B(M)</i> and <i>Type C package</i> shall be held until equilibrium conditions have been approached closely enough to demonstrate compliance with the requirements for temperature and pressure unless an exemption from these</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
19	UK/02/22	503	<p>requirements has received <i>unilateral approval</i>.</p> <p>(e) For each <i>Type B(U)</i>, <i>Type B(M)</i> and <i>Type C package</i>, it shall be ensured by inspection and/or appropriate tests that all closures, valve and other openings of the <i>containment system</i> through which the <i>radioactive contents</i> might escape are properly closed and, where appropriate, sealed in the manner for which the demonstrations of compliance with the requirements of paras 656 and 669 were made.</p> <p>(f) For each <i>special form radioactive material</i>, it shall be ensured that all the requirements specified in the approval certificate and the relevant provisions of these Regulations have been satisfied.</p> <p>(g) For <i>packages</i> containing <i>fissile material</i> the measurement specified in para. 674(b) and the tests to demonstrate closure of each <i>package</i> as specified in para. 677 shall be performed where applicable.</p> <p>(h) For each <i>low dispersible radioactive material</i>, it shall be ensured that all the requirements specified in the approval certificate and the relevant provisions of these Regulations have been satisfied.</p>	<p>requirements has received <i>unilateral approval</i>.</p> <p>(e) For each <i>Type B(U)</i>, <i>Type B(M)</i> and <i>Type C package</i>, it shall be ensured by inspection and/or appropriate tests that all closures, valve and other openings of the <i>containment system</i> through which the <i>radioactive contents</i> might escape are properly closed and, where appropriate, sealed in the manner for which the demonstrations of compliance with the requirements of paras 656 and 669 were made.</p> <p>(f) For each <i>special form radioactive material</i>, it shall be ensured that all the requirements specified in the approval certificate and the relevant provisions of these Regulations have been satisfied.</p> <p>(g) For <i>packages</i> containing <i>fissile material</i> the measurement specified in para. 674(b) and the tests to demonstrate closure of each <i>package</i> as specified in para. 677 shall be performed where applicable.</p> <p>(h) For each <i>low dispersible radioactive material</i>, it shall be ensured that all the requirements specified in the approval certificate and the relevant provisions of these Regulations have been satisfied.</p>
19	UK/02/22	503	<p>503. A <i>package</i> shall not contain any other items except such articles and documents as</p>	<p>503. A <i>package</i> shall not contain any other items unless there is no interaction between</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
20	Canada/02/04 (1 of 2) and France/02/17	Table VIII footnote “c”	<p>are necessary for the use of the <i>radioactive material</i>. This requirement shall not preclude the transport of <i>low specific activity material</i> or <i>surface contaminated objects</i> with other items. The transport of such articles and documents in a <i>package</i>, or of <i>low specific activity material</i> or <i>surface contaminated objects</i> with other items may be permitted provided that there is no interaction between them and the <i>packaging</i> or its <i>radioactive contents</i> that would reduce the safety of the <i>package</i>.</p>	<p>them and the <i>packaging</i> or its <i>radioactive contents</i>, or that would reduce the safety of the <i>package</i>.</p>
			<p>Table VIII footnote “c”</p> <p>° UN 2977 and UN 2978 are special cases without a unique relationship with the Schedules.</p>	<p>Table VIII footnote “c”</p> <p>° In the case of non-fissile or fissile excepted uranium hexafluoride, the UN 2978 and the proper shipping name and description, “RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, non-fissile or fissile excepted,” takes precedence over other UN numbers applicable to non-fissile and fissile excepted. In the case of uranium hexafluoride that is fissile material the UN 2977 and the proper shipping name, “RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, FISSILE,” takes precedence over other UN numbers applicable to fissile material.</p>

Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
21	UK/02/25	537	<p>537. Each <i>package</i> which conforms to:</p> <p>(a) an <i>IP-1</i>, an <i>IP-2</i> or an <i>IP-3 design</i> shall be legibly and durably marked on the outside of the <i>packaging</i> with “TYPE IP-1”, “TYPE IP-2” or “TYPE IP-3” as appropriate;</p> <p>(b) a <i>Type A package design</i> shall be legibly and durably marked on the outside of the <i>packaging</i> with “TYPE A”;</p> <p>(c) an <i>IP-2</i>, an <i>IP-3</i> or a <i>Type A package design</i> shall be legibly and durably marked on the outside of the international <i>vehicle</i> registration code (VRI Code) of the country of origin of <i>design</i> and the name of the manufacturers, or other identification of the <i>packaging</i> specified by the <i>competent authority</i>.</p>	<p>537. Each <i>package</i> which conforms to:</p> <p>(a) an <i>IP-1</i>, an <i>IP-2</i> or an <i>IP-3 design</i> shall be legibly and durably marked on the outside of the <i>packaging</i> with “TYPE IP-1”, “TYPE IP-2” or “TYPE IP-3” as appropriate;</p> <p>(b) a <i>Type A package design</i> shall be legibly and durably marked on the outside of the <i>packaging</i> with “TYPE A”;</p> <p>(c) an <i>IP-1</i>, an <i>IP-2</i>, an <i>IP-3</i> or a <i>Type A - package design</i> shall be legibly and durably marked on the outside of the international <i>vehicle</i> registration code (VRI Code) of the country of origin of <i>design</i> and the name of the manufacturers, or other identification of the <i>packaging</i> specified by the <i>competent authority</i>.</p>
22	UK/02/66	537	<p>537. Each <i>package</i> which conforms to:</p> <p>(a) an <i>IP-1</i>, an <i>IP-2</i> or an <i>IP-3 design</i> shall be legibly and durably marked on the outside of the <i>packaging</i> with “TYPE IP-1”, “TYPE IP-2” or “TYPE IP-3” as appropriate;</p> <p>(b) a <i>Type A package design</i> shall be legibly and durably marked on the outside of the <i>packaging</i> with “TYPE A”;</p> <p>(c) an <i>IP-2</i>, an <i>IP-3</i> or a <i>Type A package</i></p>	<p>537. Each <i>package</i> which conforms to:</p> <p>(a) an <i>IP-1</i>, an <i>IP-2</i> or an <i>IP-3 design</i> shall be legibly and durably marked on the outside of the <i>packaging</i> with “TYPE IP-1”, “TYPE IP-2” or “TYPE IP-3” as appropriate;</p> <p>(b) a <i>Type A package design</i> shall be legibly and durably marked on the outside of the <i>packaging</i> with “TYPE A”;</p> <p>(c) an <i>IP-2</i>, an <i>IP-3</i> or a <i>Type A package</i></p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
23	UK/02/28	566	<p><i>design</i> shall be legibly and durably marked on the outside of the <i>packaging</i> with the international <i>vehicle</i> registration code (VRI Code) of the country of origin of <i>design</i> and the name of the manufacturer, or other identification of the <i>packaging</i> specified by the <i>competent authority</i>.</p> <p>566. Loading of <i>freight containers</i> and accumulation of <i>packages, overpacks</i> and <i>freight containers</i> shall be controlled as follows:</p> <p>(a) Except under the condition of <i>exclusive use</i>, the total number of <i>packages, overpacks</i> and <i>freight containers</i> aboard a single <i>conveyance</i> shall be so limited that the total sum of the <i>transport indexes</i> aboard the <i>conveyance</i> does not exceed the values shown in Table IX. For consignments of LSA-I material there shall be no limit on the sum of the transport indexes.</p> <p>(b) Where a consignment is transported under exclusive use, there shall be no limit on the sum of the transport indexes aboard a single conveyance.</p> <p>(c) The <i>radiation level</i> under routine conditions of transport shall not exceed 2 mSv/h at any point on, and 0.1 mSv/h at 2 m from, the external surface of the <i>conveyance</i>, except for <i>consignments</i></p>	<p><i>design</i> shall be legibly and durably marked on the outside of the <i>packaging</i> with the international <i>vehicle</i> registration code (VRI Code) of the country of origin of <i>design</i> and the name of the designer of the package, or other identification of the <i>packaging</i> specified by the <i>competent authority</i>.</p> <p>566. Loading of <i>freight containers</i> and accumulation of <i>packages, overpacks</i> and <i>freight containers</i> shall be controlled as follows:</p> <p>(a) Except under the condition of <i>exclusive use</i>, and for consignments of LSA-I material, the total number of <i>packages, overpacks</i> and <i>freight containers</i> aboard a single <i>conveyance</i> shall be so limited that the total sum of the <i>transport indexes</i> aboard the <i>conveyance</i> does not exceed the values shown in Table IX.</p> <p>(b) The <i>radiation level</i> under routine conditions of transport shall not exceed 2 mSv/h at any point on, and 0.1 mSv/h at 2 m from, the external surface of the <i>conveyance</i>, except for <i>consignments</i></p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
24	EU/02/01 and Germany/02/01, UK/02/73	622 and consequential changes in 624, 625, 627, 628 and 646b	<p>transported under <i>exclusive use</i> by road or rail, for which the radiation limits around the <i>vehicle</i> are set forth in para 572(b) and (c).</p> <p>(d) The total sum of the <i>criticality safety indexes</i> in a <i>freight container</i> and aboard a <i>conveyance</i> shall not exceed the values shown in Table X.</p>	<p>transported under <i>exclusive use</i> by road or rail, for which the radiation limits around the <i>vehicle</i> are set forth in para 572(b) and (c).</p> <p>(c) The total sum of the <i>criticality safety indexes</i> in a <i>freight container</i> and aboard a <i>conveyance</i> shall not exceed the values shown in Table X.</p>
25	France/02/04	622 (alternate proposal A) and consequential changes in 624, 625, 627, 628 and 646b	<p>622. A <i>package</i>, to be qualified as a <i>Type IP-2</i>, shall be designed to meet the requirements for <i>Type IP-1</i> as specified in para. 621 and, in addition, if it were subjected to the tests specified in paras 722 and 723, it would - prevent:</p> <p>(a) loss or dispersal of the <i>radioactive contents</i>; and</p> <p>(b) loss of shielding integrity which would result in more than a 20% increase in the <i>radiation level</i> at any external surface of the <i>package</i>.</p>	<p>622. A <i>package</i>, to be qualified as a <i>Type IP-2</i>, shall be designed to meet the requirements for <i>Type IP-1</i> as specified in para. 621 and, in addition, if it were subjected to the tests specified in paras 722 and 723, it would - prevent:</p> <p>(a) loss or dispersal of the <i>radioactive contents</i>; and</p> <p>(b) loss of shielding integrity which would result in more than a 20% increase in the maximum radiation level at any external surface of the <i>package</i>.</p>
			<p>622. A <i>package</i>, to be qualified as a <i>Type IP-2</i>, shall be designed to meet the requirements for <i>Type IP-1</i> as specified in para. 621 and, in addition, if it were subjected to the tests specified in paras 722 and 723, it would prevent:</p> <p>(a) loss or dispersal of the <i>radioactive</i></p>	<p>622. A <i>package</i>, to be qualified as a <i>Type IP-2</i>, shall be designed to meet the requirements for <i>Type IP-1</i> as specified in para. 621 and, in addition, if it were subjected to the tests specified in paras 722 and 723, it would prevent:</p> <p>(a) loss or dispersal of the <i>radioactive</i></p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
26	France/02/29	see [proposal 60 for alternate] 652 and 662	<p>(b) <i>contents</i>; and loss of shielding integrity which would result in more than a 20% increase in the <i>radiation level</i> at any external surface of the <i>package</i>.</p> <p>652. Except as required in para. 617 for a package transported by air, a <i>package</i> shall be so designed that, under the ambient condition specified in para. 653, the temperature of the accessible surfaces of a <i>package</i> shall not exceed 50°C, unless the <i>package</i> is transported under <i>exclusive use</i>.</p> <p>662. Except as required in para. 617 for a <i>package</i> transported by air, the maximum temperature of any surface readily accessible during transport of a <i>package</i> shall not exceed 85°C in the absence of insulation under the ambient conditions specified in para. 653. The package shall be carried under exclusive use, as specified in para. 652, if this maximum temperature exceeds 50°C. Account may be taken of barriers or screens intended to give protection to persons without the need for the barriers or screens being subject to any test.</p>	<p>(b) <i>contents</i>; and loss of shielding integrity which would result in more than a 20% increase in the <i>transport index</i> of the <i>package</i></p> <p>652. A <i>package</i> shall be so designed that, under the ambient condition specified in para. 653 and in the absence of insulation, the temperature of the accessible surfaces of a <i>package</i> shall not exceed 50 °C, unless the <i>package</i> is transported under <i>exclusive use</i>.</p> <p>652 bis. Except as required in para. 617 for a <i>package</i> transported by air, the maximum temperature of any surface readily accessible during transport of a <i>package</i> under exclusive use shall not exceed 85°C in the absence of insulation under the ambient conditions specified in para. 653. Account may be taken of barriers or screens intended to give protection to persons without the need for the barriers or screens being subject to any test.</p> <p>662 : deleted and replaced with 652bis as above</p>
27	UK/02/35 (1 of 4) and France/02/44	672 (417bis)	<p>NOTE. Current para 672, as modified, becomes new para 417bis</p> <p>672. <i>Fissile material</i> meeting one of the provisions (a)–(d) of this paragraph is excepted from the requirement to be transported in</p>	<p>NOTE. Proposed para 417bis is based on current para 672</p>

Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p><i>packages</i> that comply with paras 673–682 as well as the other requirements of these Regulations that apply to <i>fissile material</i>. Only one type of exception is allowed per <i>consignment</i>.</p> <p>(a) A mass limit per <i>consignment</i> such that: $\frac{\text{mass of uranium-235 (g)} + \text{mass of other fissile material (g)}}{X + Y} < 1$ </p> <p>where X and Y are the mass limits defined in Table XII, provided that either:</p> <p>(i) each individual <i>package</i> contains not more than 15 g of <i>fissile material</i>; for unpackaged material, this quantity limitation shall apply to the <i>consignment</i> being carried in or on the <i>conveyance</i>, or</p> <p>(ii) the <i>fissile material</i> is a homogeneous hydrogenous solution or mixture where the ratio of fissile nuclides to hydrogen is less than 5% by mass, or</p> <p>(iii) there is not more than 5 g of <i>fissile material</i> in any 10 litre volume of material.</p> <p>Neither beryllium nor deuterium in hydrogenous material enriched in deuterium shall be present in quantities exceeding 1% of the applicable consignment mass limits provided in Table XII.</p>	<p>417bis. Packages containing <i>fissile material</i>, other than <i>packages</i> approved for the carriage of <i>fissile material</i>, shall meet one of the exceptions (a)–(d). Only one type of exception is allowed per <i>consignment</i>.</p> <p>(a) A mass limit per <i>consignment</i> such that: $\frac{\text{mass of uranium-235 (g)} + \text{mass of other fissile material (g)}}{X + Y} < 1$ </p> <p>where X and Y are the mass limits defined in Table IV, provided that either:</p> <p>(i) each individual <i>package</i> contains not more than 15 g of <i>fissile material</i>; for unpackaged material, this quantity limitation shall apply to the <i>consignment</i> being carried in or on the <i>conveyance</i>, or</p> <p>(ii) the <i>fissile material</i> is a homogeneous hydrogenous solution or mixture where the ratio of fissile nuclides to hydrogen is less than 5% by mass, or</p> <p>(iii) there is not more than 5 g of <i>fissile material</i> in any 10 litre volume of material.</p> <p>Neither beryllium nor deuterium in hydrogenous material enriched in deuterium shall be present in quantities exceeding 1% of the applicable consignment mass limits provided in Table IV.</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
28	UK/02/35 (2 of 4) see #27	672 (417 bis) (UK/02/35) related consequential changes in Table numbers and location	<p>(b) Uranium enriched in uranium-235 to a maximum of 1% by mass, and with a total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that the <i>fissile material</i> is distributed essentially homogeneously throughout the material. In addition, if uranium-235 is present in metallic, oxide or carbide forms, it shall not form a lattice arrangement.</p> <p>(c) Liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by mass, with a total plutonium and uranium-233 content not exceeding 0.002% of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2.</p> <p>(d) Packages containing, individually, a total plutonium mass not more than 1 kg, of which not more than 20% by mass may consist of plutonium-239, plutonium-241 or any combination of those radionuclides.</p>	<p>(b) Uranium enriched in uranium-235 to a maximum of 1% by mass, and with a total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that the <i>fissile material</i> is distributed essentially homogeneously throughout the material. In addition, if uranium-235 is present in metallic, oxide or carbide forms, it shall not form a lattice arrangement.</p> <p>(c) Liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by mass, with a total plutonium and uranium-233 content not exceeding 0.002% of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2.</p> <p>(d) Packages containing, individually, a total plutonium mass not more than 1 kg, of which not more than 20% by mass may consist of plutonium-239, plutonium-241 or any combination of those radionuclides.</p>
			TABLE Numbers IV/XII	TABLE XII to be moved (becomes TABLE IV) – TABLES IV – XI to have table numbers increased by one.

Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
29	UK/02/35 (3 of 4) see #27	672 (417bis) (UK/02/35) related consequential change in para 671	<p>671. <i>Fissile material</i> shall be transported so as to;</p> <p>(a) maintain subcriticality during normal and accident conditions of transport; in particular, the following contingencies shall be considered:</p> <ul style="list-style-type: none"> (i) water leaking into or out of <i>packages</i>; (ii) the loss of efficiency of built-in neutron absorbers or moderators; (iii) rearrangement of the contents either within the <i>package</i> or as a result of loss from the <i>package</i>; (iv) reduction of spaces within or between <i>packages</i>; (v) <i>packages</i> becoming immersed in water or buried in snow; and (vi) temperature changes; and <p>(b) meet the requirements:</p> <ul style="list-style-type: none"> (i) of para. 634 for <i>packages</i> containing <i>fissile material</i>; (ii) prescribed elsewhere in these Regulations which pertain to the radio-active properties of the material; and (iii) specified in paras 673–682, unless excepted by para. 672. 	<p>671. Packages designed for the carriage of <i>fissile material</i> shall;</p> <p>(a) maintain subcriticality during normal and accident conditions of transport; in particular, the following contingencies shall be considered:</p> <ul style="list-style-type: none"> (i) water leaking into or out of <i>packages</i>; (ii) the loss of efficiency of built-in neutron absorbers or moderators; (iii) rearrangement of the contents either within the <i>package</i> or as a result of loss from the <i>package</i>; (iv) reduction of spaces within or between <i>packages</i>; (v) <i>packages</i> becoming immersed in water or buried in snow; and (vi) temperature changes; and <p>(b) meet the requirements:</p> <ul style="list-style-type: none"> (i) of para. 634 for <i>packages</i> containing <i>fissile material</i>; (ii) prescribed elsewhere in these Regulations which pertain to the radio-active properties of the material; and (iii) specified in paras 673–682.

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
30	UK/02/35 (4 of 4) see #27	672 (417bis) (UK/02/35) related consequential changes in paras 226, 515, TABLE VIII, 541, 549, 802, 812	Current reference to para 672 in : 226 (a) (iii) and (iv) 515 (c) TABLE VIII footnote 541 549 (i) 802 (a) (iv) 812	Change 672 to 417bis in: 226 (a) (iii) and (iv) 515 (c) TABLE VIII footnote 541 549 (i) 802 (a) (iv) 812
31	France/02/37	672	672. <i>Fissile material</i> meeting one of the provisions (a)–(d) of this paragraph is excepted from the requirement to be transported in <i>packages</i> that comply with paras 673–682 as well as the other requirements of these Regulations that apply to <i>fissile material</i> . Only one type of exception is allowed per <i>consignment</i> . (a) A mass limit per <i>consignment</i> such that: $\frac{\text{mass of uranium-235 (g)} + \text{mass of other fissile material (g)}}{X} < 1$ where X and Y are the mass limits defined in Table XII, provided that either: (i) each individual <i>package</i> contains not more than 15 g of <i>fissile material</i> ; for	672. <i>Fissile material</i> meeting one of the provisions (a)–(d) of this paragraph is excepted from the requirement to be transported in <i>packages</i> that comply with paras 673–682 as well as the other requirements of these Regulations that apply to <i>fissile material</i> . Only one type of exception is allowed per <i>consignment</i> . (a) A mass limit per <i>consignment</i> such that: $\frac{\text{mass of uranium-235 (g)} + \text{mass of other fissile material (g)}}{X} < 1$ where X and Y are the mass limits defined in Table XII, provided that either: (i) each individual <i>package</i> contains not more than 15 g of <i>fissile material</i> ; for

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
			<p>unpacked material, this quantity limitation shall apply to the - <i>consignment</i> being carried in or on the <i>conveyance</i>, or</p> <p>(ii) the <i>fissile material</i> is a homogeneous hydrogenous solution or mixture where the ratio of fissile nuclides to hydrogen is less than 5% by mass, or</p> <p>(iii) there is not more than 5 g of <i>fissile material</i> in any 10 litre volume of material.</p> <p>Neither beryllium nor deuterium in hydrogenous material enriched in deuterium shall be present in quantities exceeding 1% of the consignment mass limits provided in Table XII.</p> <p>(b) Uranium enriched in uranium-235 to a maximum of 1% by mass, and with a total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that the <i>fissile material</i> is distributed essentially homogeneously throughout the material. In addition, if uranium-235 is present in metallic, oxide or carbide forms, it shall not form a lattice arrangement.</p> <p>(c) Liquid solutions of uranyl nitrate enriched</p>	<p>unpacked material, this quantity limitation shall apply to the - <i>consignment</i> being carried in or on the <i>conveyance</i>, or</p> <p>(ii) the <i>fissile material</i> is a homogeneous hydrogenous solution or mixture where the ratio of fissile nuclides to hydrogen is less than 5% by mass, or</p> <p>(iii) there is not more than 5 g of <i>fissile material</i> in any 10 litre volume of material.</p> <p>Neither beryllium nor deuterium shall be present in quantities exceeding 1% of the applicable consignment mass limits provided in Table XII, except for deuterium in natural concentration in hydrogen.</p> <p>(b) Uranium enriched in uranium-235 to a maximum of 1% by mass, and with a total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that the <i>fissile material</i> is distributed essentially homogeneously throughout the material. In addition, if uranium-235 is present in metallic, oxide or carbide forms, it shall not form a lattice arrangement.</p> <p>(c) Liquid solutions of uranyl nitrate enriched</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
32	Sweden/02/03	672	<p>in uranium-235 to a maximum of 2% by mass, with a total plutonium and uranium-233 content not exceeding 0.002% of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2.</p> <p>(d) Packages containing, individually, a total plutonium mass not more than 1 kg, of which not more than 20% by mass may consist of plutonium-239, plutonium-241 or any combination of those radionuclides.</p>	<p>in uranium-235 to a maximum of 2% by mass, with a total plutonium and uranium-233 content not exceeding 0.002% of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2.</p> <p>(d) Packages containing, individually, a total plutonium mass not more than 1 kg, of which not more than 20% by mass may consist of plutonium-239, plutonium-241 or any combination of those radionuclides.</p>
		672	<p>672. <i>Fissile material</i> meeting one of the provisions (a)–(d) of this paragraph is excepted from the requirement to be transported in <i>packages</i> that comply with paras 673–682 as well as the other requirements of these Regulations that apply to <i>fissile material</i>. Only one type of exception is allowed per <i>consignment</i>.</p> <p>(a) A mass limit per <i>consignment</i> such that:</p> $\frac{\text{mass of uranium-235 (g)} + \text{mass of other fissile material (g)}}{X} < 1$ <p>where X and Y are the mass limits defined in Table XII, provided that either:</p>	<p>672. <i>Fissile material</i> meeting one of the provisions (a)–(d) of this paragraph is excepted from the requirement to be transported in <i>packages</i> that comply with paras 673–682 as well as the other requirements of these Regulations that apply to <i>fissile material</i>, provided that the smallest external dimension of each <i>package</i> is not less than 10 cm. Only one type of exception is allowed per <i>consignment</i>.</p> <p>(a) A mass limit per <i>consignment</i> such that:</p> $\frac{\text{mass of uranium-235 (g)} + \text{mass of other fissile material (g)}}{X} < 1$ <p>where X and Y are the mass limits defined in Table XII, provided that either:</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>(i) each individual <i>package</i> contains not more than 15 g of <i>fissile material</i>; for unpackaged material, this quantity limitation shall apply to the - <i>consignment</i> being carried in or on the <i>conveyance</i>, or</p> <p>(ii) the <i>fissile material</i> is a homogeneous hydrogenous solution or mixture where the ratio of fissile nuclides to hydrogen is less than 5% by mass, or</p> <p>(iii) there is not more than 5 g of <i>fissile material</i> in any 10 litre volume of material.</p> <p>Neither beryllium nor deuterium in hydrogenous material enriched in deuterium shall be present in quantities exceeding 1% of the applicable consignment mass limits provided in Table XII.</p> <p>(b) Uranium enriched in uranium-235 to a maximum of 1% by mass, and with a total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that the <i>fissile material</i> is distributed essentially homogeneously throughout the material. In addition, if uranium-235 is present in metallic, oxide or carbide forms, it shall not form a lattice arrangement.</p>	<p>(i) each individual <i>package</i> contains not more than 15 g of <i>fissile material</i>; for unpackaged material, this quantity limitation shall apply to the - <i>consignment</i> being carried in or on the <i>conveyance</i>, or</p> <p>(ii) the <i>fissile material</i> is a homogeneous hydrogenous solution or mixture where the ratio of fissile nuclides to hydrogen is less than 5% by mass, or</p> <p>(iii) there is not more than 5 g of <i>fissile material</i> in any 10 litre volume of material.</p> <p>Neither beryllium nor deuterium in hydrogenous material enriched in deuterium shall be present in quantities exceeding 1% of the applicable consignment mass limits provided in Table XII.</p> <p>(b) Uranium enriched in uranium-235 to a maximum of 1% by mass, and with a total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that the <i>fissile material</i> is distributed essentially homogeneously throughout the material. In addition, if uranium-235 is present in metallic, oxide or carbide forms, it shall not form a lattice arrangement.</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
33	UK/02/37 (1 of 4)	672	<p>(c) Liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by mass, with a total plutonium and uranium-233 content not exceeding 0.002% of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2.</p> <p>(d) Packages containing, individually, a total plutonium mass not more than 1 kg, of which not more than 20% by mass may consist of plutonium-239, plutonium-241 or any combination of those radionuclides.</p>	<p>(c) Liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by mass, with a total plutonium and uranium-233 content not exceeding 0.002% of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2.</p> <p>(d) Packages containing, individually, a total plutonium mass not more than 1 kg, of which not more than 20% by mass may consist of plutonium-239, plutonium-241 or any combination of those radionuclides.</p>
			<p>672. <i>Fissile material</i> meeting one of the provisions (a)–(d) of this paragraph is excepted from the requirement to be transported in <i>packages</i> that comply with paras 673–682 as well as the other requirements of these Regulations that apply to <i>fissile material</i>. Only one type of exception is allowed per <i>consignment</i>.</p> <p>(a) A mass limit per <i>consignment</i> such that:</p> $\frac{\text{mass of uranium-235 (g)} + \text{mass of other fissile material (g)}}{X} < 1$ <p>where X and Y are the mass limits defined in Table XII, provided that either:</p> <p>(i) each individual <i>package</i> contains not more than 15 g of <i>fissile material</i>; for</p>	<p>672. <i>Fissile material</i> meeting one of the provisions (a)–(d) of this paragraph is excepted from the requirement to be transported in <i>packages</i> that comply with paras 673–682 as well as the other requirements of these Regulations that apply to <i>fissile material</i>. Only one type of exception is allowed per <i>consignment</i>.</p> <p>(a) A mass limit per <i>consignment</i> such that:</p> $\text{CSI} = \frac{\text{mass of uranium-235 (g)} + \text{mass of other fissile material (g)}}{Y} * 50$ <p>where X and Y are the mass limits defined in Table XII, provided that either:</p> <p>(i) each individual <i>package</i> contains not more than 15 g of <i>fissile material</i>, for</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
			<p>unpacked material, this quantity limitation shall apply to the - <i>consignment</i> being carried in or on the <i>conveyance</i>, or</p> <p>(ii) the <i>fissile material</i> is a homogeneous hydrogenous solution or mixture where the ratio of fissile nuclides to hydrogen is less than 5% by mass, or</p> <p>(iii) there is not more than 5 g of <i>fissile material</i> in any 10 litre volume of material.</p> <p>Neither beryllium nor deuterium in hydrogenous material enriched in deuterium shall be present in quantities exceeding 1% of the applicable consignment mass limits provided in Table XII.</p> <p>(b) Uranium enriched in uranium-235 to a maximum of 1% by mass, and with a total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that the <i>fissile material</i> is distributed essentially homogeneously throughout the material. In addition, if uranium-235 is present in metallic, oxide or carbide forms, it shall not form a lattice arrangement.</p> <p>(c) Liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by</p>	<p>unpacked material, this quantity limitation shall apply to the - <i>consignment</i> being carried in or on the <i>conveyance</i>, or</p> <p>(ii) the <i>fissile material</i> is a homogeneous hydrogenous solution or mixture where the ratio of fissile nuclides to hydrogen is less than 5% by mass, or</p> <p>(iii) there is not more than 5 g of <i>fissile material</i> in any 10 litre volume of material.</p> <p>Neither beryllium nor deuterium in hydrogenous material enriched in deuterium shall be present in quantities exceeding 1% of the applicable consignment mass limits provided in Table XII.</p> <p>(b) Uranium enriched in uranium-235 to a maximum of 1% by mass, and with a total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that the <i>fissile material</i> is distributed essentially homogeneously throughout the material. In addition, if uranium-235 is present in metallic, oxide or carbide forms, it shall not form a lattice arrangement.</p> <p>(c) Liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
34	UK/02/37 (2 of 4) see #33	672 (UK/02/37) related change in 544	<p>mass, with a total plutonium and uranium-233 content not exceeding 0.002% of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2.</p> <p>(d) Packages containing, individually, a total plutonium mass not more than 1 kg, of which not more than 20% by mass may consist of plutonium-239, plutonium-241 or any combination of those radionuclides.</p>	<p>mass, with a total plutonium and uranium-233 content not exceeding 0.002% of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2.</p> <p>(d) Packages containing, individually, a total plutonium mass not more than 1 kg, of which not more than 20% by mass may consist of plutonium-239, plutonium-241 or any combination of those radionuclides.</p>
35	UK/02/37 (3 of 4) see #33	672 (UK/02/37) related change to TABLE X header	<p>544. Each label conforming to the model in Fig. 5 shall be completed with the <i>criticality safety index (CSI)</i> as stated in the certificate of approval for <i>special arrangement</i> or the certificate of approval for the <i>package design</i> issued by the <i>competent authority</i>.</p>	<p>544. Each label conforming to the model in Fig. 5 shall be completed with the <i>criticality safety index (CSI)</i> as stated in the certificate of approval for <i>special arrangement</i>. the certificate of approval for the <i>package design</i> issued by the <i>competent authority</i> or as calculated in accordance with 672 (a).</p>
36	UK/02/37 (4 of 4) see #33	672 (UK/02/37)	<p>TABLE X. CSI LIMITS FOR FREIGHT CONTAINERS AND CONVEYANCES CONTAINING FISSILE MATERIAL</p> <p>Current reference to para 672 in:</p>	<p>TABLE X. CSI LIMITS FOR FREIGHT CONTAINERS AND CONVEYANCES</p> <p>Change references in paras 541 and 549(i) from 672 to 672(b)-(d)</p>

Change	Proposal	Para related consequential changes in paras 541 and 549	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
37	USA/02/02	672	<p>672. <i>Fissile material</i> meeting one of the provisions (a)–(d) of this paragraph is excepted from the requirement to be transported in <i>packages</i> that comply with paras 673–682 as well as the other requirements of these Regulations that apply to <i>fissile material</i>. Only one type of exception is allowed per consignment.</p> <p>(a) A mass limit per <i>consignment</i> such that:</p> $\frac{\text{mass of uranium-235 (g)} + \text{mass of other fissile material (g)}}{X + Y} < 1$ <p>where X and Y are the mass limits defined in Table XII, provided that either:</p> <p>(i) each individual <i>package</i> contains not more than 15 g of <i>fissile material</i>; for unpackaged material, this quantity limitation shall apply to the <i>consignment</i> being carried in or on the <i>conveyance</i>, or</p> <p>(ii) the <i>fissile material</i> is a homogeneous hydrogenous solution or mixture where the ratio of fissile nuclides to hydrogen is less than 5% by mass, or</p>	<p>672. <i>Fissile material</i> meeting one of the provisions (a) - (d) of this paragraph is excepted from the requirement to be transported in <i>packages</i> that comply with paras 673-682 as well as the other requirements of these Regulations that apply to <i>fissile material</i>.</p> <p>(a) Individual package containing 2 grams or less <i>fissile material</i>.</p> <p>(b) Individual package containing 15 grams or less of <i>fissile material</i> provided the package has at least 200 grams of solid non-fissile, material for every gram of <i>fissile material</i>. Lead, beryllium, graphite, and hydrogenous material enriched in deuterium may be present in the package, but must not be included in determining the required mass of solid non-fissile material.</p> <p>(c) Low concentrations of solid fissile material commingled with solid non-fissile material, provided that:</p>

Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>(iii) there is not more than 5 g of <i>fissile material</i> in any 10 litre volume of material.</p> <p>Neither beryllium nor deuterium in hydrogenous material enriched in deuterium shall be present in quantities exceeding 1% of the applicable consignment mass limits provided in Table XII.</p> <p>(b) Uranium enriched in uranium-235 to a maximum of 1% by mass, and with a total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that the <i>fissile material</i> is distributed essentially homogeneously throughout the material. In addition, if uranium-235 is present in metallic, oxide or carbide forms, it shall not form a lattice arrangement.</p> <p>(c) Liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by mass, with a total plutonium and uranium-</p>	<p>provided that:</p> <ol style="list-style-type: none"> 1) There is at least 2000 grams of non-fissile material for every gram of <i>fissile material</i>, and 2) There is no more than 180 grams of <i>fissile material</i> distributed within any 360 kg of contiguous non-fissile material. <p>The material can be packaged or unpackaged according to para 523. Beryllium, graphite, and hydrogenous material enriched in deuterium may be present, but must not be included in determining the required mass of solid non-fissile material.</p> <p>(c) Uranium enriched in uranium-235 to a maximum of 1 percent by mass, and with total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that beryllium, graphite, and hydrogenous material enriched in deuterium constitute less than 5% of the uranium mass.</p> <p>(d) Liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by mass, with a total plutonium and uranium-</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
38	USA/02/01	677	<p>233 content not exceeding 0.002% of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2.</p> <p>(d) Packages containing, individually, a total plutonium mass not more than 1 kg, of which not more than 20% by mass may consist of plutonium-239, plutonium-241 or any combination of those radionuclides.</p> <p>677. For a <i>package</i> in isolation, it shall be assumed that water can leak into or out of all void spaces of the <i>package</i>, including those within the <i>containment system</i>. However, if the <i>design</i> incorporates special features to prevent such leakage of water into or out of certain void spaces, even as a result of error, absence of leakage may be assumed in respect of those void spaces. Special features shall include the following:</p> <p>(a) Multiple high standard water barriers, each of which would remain watertight if the <i>package</i> were subject to the tests prescribed in para. 682(b), a high degree of quality control in the manufacture, maintenance and repair of <i>packagings</i> and tests to demonstrate the closure of each <i>package</i> before each <i>shipment</i>; or</p> <p>(b) For <i>packages</i> containing uranium</p>	<p>233 content not exceeding 0.002% of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2. The package shall meet the requirements of para 646.</p> <p>(f) Packages containing, individually, a total plutonium mass not more than 1 kg, of which not more than 20% by mass may consist of plutonium-239, plutonium-241 or any combination of those radionuclides.</p> <p>677. For a <i>package</i> in isolation, it shall be assumed that water can leak into or out of all void spaces of the <i>package</i>, including those within the <i>containment system</i>. However, if the <i>design</i> incorporates special features to prevent such leakage of water into or out of certain void spaces, even as a result of error, absence of leakage may be assumed in respect of those void spaces. Special features shall include the following:</p> <p>(a) Multiple high standard water barriers, each of which would remain watertight if the <i>package</i> were subject to the tests prescribed in para. 682(b), a high degree of quality control in the manufacture, maintenance and repair of <i>packagings</i> and tests to demonstrate the closure of each <i>package</i> before each <i>shipment</i>; or</p> <p>(b) For <i>packages</i> containing uranium</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
39	Canada/02/05	709	<p>hexafluoride only:</p> <p>(i) <i>packages</i> where, following the tests prescribed in para. 682(b), there is no physical contact between the valve and any other component of the <i>packaging</i> other than at its original point of attachment and where, in addition, following the test prescribed in para. 728 the valves remain leaktight; and</p> <p>(ii) a high degree of quality control in the manufacture, maintenance and repair of <i>packagings</i> coupled with tests to demonstrate closure of each <i>package</i> before each <i>shipment</i>.</p>	<p>hexafluoride, with enrichment of 5 mass percent uranium-235 or less:</p> <p>(i) <i>packages</i> where, following the tests prescribed in para. 682(b), there is no physical contact between the valve and any other component of the <i>packaging</i> other than at its original point of attachment and where, in addition, following the test prescribed in para. 728 the valves remain leaktight; and</p> <p>(ii) a high degree of quality control in the manufacture, maintenance and repair of <i>packagings</i> coupled with tests to demonstrate closure of each <i>package</i> before each <i>shipment</i>.</p>
			<p>709. Specimens that comprise or simulate <i>radioactive material</i> enclosed in a sealed capsule may be excepted from:</p> <p>(a) The tests prescribed in paras 705 and 706 provided the mass of the <i>special form radioactive material</i> is less than 200 g and they are alternatively subjected to the Class 4 impact test prescribed in the International Organization for Standardization document ISO 2919: “Sealed Radioactive Sources — Classification” [11], and</p>	<p>709. Specimens that comprise or simulate <i>radioactive material</i> enclosed in a sealed capsule may be excepted from:</p> <p>(a) The tests prescribed in paras 705 and 706 provided the mass of the <i>special form radioactive material</i></p> <p>i) is less than 200 g and they are alternately subjected to the Class 4 impact test prescribed in the International Organization for Standardization document ISO</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
			<p>(b) The test prescribed in para. 708 provided they are alternatively subjected to the Class 6 temperature test specified in the International Organization for Standardization document ISO 2919: “Sealed Radioactive Sources — Classification” [11].</p>	<p>2919: “Sealed Radioactive Sources — Classification” [11], or is less than 500 g and they are alternately subjected to the Class 5 impact test prescribed in the International Organization for Standardization document ISO 2919: “Sealed Radioactive Sources — Classification” [11], and</p> <p>(b) The test prescribed in para. 708 provided they are alternatively subjected to the Class 6 temperature test specified in the International Organization for Standardization document ISO 2919: “Sealed Radioactive Sources — Classification” [11].</p>
40	France/02/34	722	<p>722. Free drop test: The specimen shall drop onto the target so as to suffer maximum damage in respect of the safety features to be tested.</p> <p>(a) The height of drop measured from the lowest point of the specimen to the upper surface of the target shall be not less than the distance specified in Table XIII for the applicable mass. The target shall be as defined in para. 717.</p>	<p>722. Free drop test: The specimen shall drop onto the target so as to suffer maximum damage in respect of the safety features to be tested.</p> <p>(a) The height of drop measured from the lowest point of the specimen to the upper surface of the target shall be not less than the distance specified in Table XIII for the applicable mass. For packages with a dimension exceeding 1.2 m, the height of</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
41	UK/02/71	803	<p>(b) For rectangular fibreboard or wood <i>packages</i> not exceeding a mass of 50 kg, a separate specimen shall be subjected to a free drop onto each corner from a height of 0.3 m.</p> <p>(c) For cylindrical fibreboard <i>packages</i> not exceeding a mass of 100 kg, a separate specimen shall be subjected to a free drop onto each of the quarters of each rim from a height of 0.3 m.</p>	<p>drop measured for any point from its theoretical position considering the package laying on the target (with the orientation it has in routine conditions of transport or handling) and its position in the specimen before drop shall not exceed 1.2 m plus the distance specified in Table XIII for the applicable mass. The target shall be as defined in para. 717.</p> <p>(b) For rectangular fibreboard or wood <i>packages</i> not exceeding a mass of 50 kg, a separate specimen shall be subjected to a free drop onto each corner from a height of 0.3 m.</p> <p>(c) For cylindrical fibreboard <i>packages</i> not exceeding a mass of 100 kg, a separate specimen shall be subjected to a free drop onto each of the quarters of each rim from a height of 0.3 m.</p>
803.	803		<p>The <i>design</i> for special form radioactive material shall require unilateral approval. The <i>design</i> for low dispersible radioactive material shall require multilateral approval. In both cases, an application for approval shall include:</p> <p>(a) a detailed description of the <i>radioactive material</i> or, if a capsule, the contents; particular reference shall be made to both physical and chemical states;</p>	<p>The <i>design</i> for special form radioactive material shall require unilateral approval. The <i>design</i> for low dispersible radioactive material shall require multilateral approval. In both cases, an application for approval shall include:</p> <p>(a) a detailed description of the <i>radioactive material</i> or, if a capsule, the contents; particular reference shall be made to both physical and chemical states;</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>(b) a detailed statement of the <i>design</i> of any capsule to be used;</p> <p>(c) a statement of the tests which have been done and their results, or evidence based on calculative methods to show that the <i>radioactive material</i> is capable of meeting the performance standards, or other evidence that the <i>special form radioactive material</i> or <i>low dispersible radioactive material</i> meets the applicable requirements of these Regulations;</p> <p>(d) a specification of the applicable <i>quality assurance</i> programme as required in para. 310; and</p> <p>(e) any proposed pre-shipment actions for use in the <i>consignment</i> of <i>special form radioactive material</i> or <i>low dispersible radioactive material</i>.</p>	<p>(b) a detailed statement of the <i>design</i> of any capsule to be used;</p> <p>(c) a statement of the tests which have been done and their results, or evidence based on calculative methods to show that the <i>radioactive material</i> is capable of meeting the performance standards, or other evidence that the <i>special form radioactive material</i> or <i>low dispersible radioactive material</i> meets the applicable requirements of these Regulations;</p> <p>(d) A quantitative statement of any time-dependent features of a special form design likely to affect its ability to meet the requirements for special form radioactive material in paras 602 to 604.</p> <p>(e) a specification of the applicable <i>quality assurance</i> programme as required in para. 310; and</p> <p>(f) any proposed pre-shipment actions for use in the <i>consignment</i> of <i>special form radioactive material</i> or <i>low dispersible radioactive material</i>.</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
42	Canada/02/12 (4 of 6) see #6	805	<p>805. The approval of <i>designs</i> for <i>packages</i> containing 0.1 kg or more of uranium hexafluoride requires that:</p> <p>(a) After 31 December 2000, each <i>design</i> that meets the requirements of para. 632 shall require <i>multilateral approval</i>. After 31 December 2003, each <i>design</i> that meets the requirements of paras 629–631 shall require <i>unilateral approval</i> by the <i>competent authority</i> of the country of origin of the <i>design</i>;</p> <p>(b) The application for approval shall include all information necessary to satisfy the <i>competent authority</i> that the <i>design</i> meets the requirements of para. 629, and a specification of the applicable <i>quality assurance</i> programme as required in para. 310;</p> <p>(c) The <i>competent authority</i> shall establish an approval certificate stating that the approved <i>design</i> meets the requirements of para. 629 and shall attribute to that <i>design</i> an identification mark.</p>	<p>805. The approval of <i>designs</i> for <i>packages</i> containing 0.1 kg or more of uranium hexafluoride requires that:</p> <p>(a) Each design that meets the requirements of para. 632 shall require multilateral approval.</p> <p>(a bis) Each design that meets the requirement of paras 629-631 shall require unilateral approval by the competent authority of the country of origin of the design, unless multilateral approval is otherwise required by these regulations.</p> <p>(b) The application for approval shall include all information necessary to satisfy the <i>competent authority</i> that the <i>design</i> meets the requirements of para. 629, and a specification of the applicable <i>quality assurance</i> programme as required in para. 310;</p> <p>(c) The <i>competent authority</i> shall establish an approval certificate stating that the approved <i>design</i> meets the requirements of para. 629 and shall attribute to that <i>design</i> an identification mark.</p>
43	UK/02/39 (1 of 4)	805	<p>805. The approval of <i>designs</i> for <i>packages</i> containing 0.1 kg or more of uranium hexafluoride requires that:</p>	<p>805. The approval of <i>designs</i> for <i>packages</i> containing 0.1 kg or more of uranium hexafluoride requires that:</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
44	UK/02/40	805	<p>(a) After 31 December 2000, each <i>design</i> that meets the requirements of para. 632 shall require <i>multilateral approval</i>. After 31 December 2003, each <i>design</i> that meets the requirements of paras 629–631 shall require <i>unilateral approval</i> by the <i>competent authority</i> of the country of origin of the <i>design</i>;</p> <p>(b) The application for approval shall include all information necessary to satisfy the <i>competent authority</i> that the <i>design</i> meets the requirements of para. 629, and a specification of the applicable <i>quality assurance</i> programme as required in para. 310;</p> <p>(c) The <i>competent authority</i> shall establish an approval certificate stating that the approved <i>design</i> meets the requirements of para. 629 and shall attribute to that <i>design</i> an identification mark.</p>	<p>(a) Each <i>design</i> that meets the requirements of para. 632 shall require <i>multilateral approval</i>. Each <i>design</i> that meets the requirements of paras 629–631 shall require <i>unilateral approval</i> by the <i>competent authority</i> of the country of origin of the <i>design</i>;</p> <p>(b) The application for approval shall include all information necessary to satisfy the <i>competent authority</i> that the <i>design</i> meets the requirements of para. 629, and a specification of the applicable <i>quality assurance</i> programme as required in para. 310;</p> <p>(c) The <i>competent authority</i> shall establish an approval certificate stating that the approved <i>design</i> meets the requirements of para. 629 and shall attribute to that <i>design</i> an identification mark.</p>
44	UK/02/40	805	<p>805. The approval of <i>designs</i> for <i>packages</i> containing 0.1 kg or more of uranium hexafluoride requires that:</p> <p>(a) After 31 December 2000, each <i>design</i> that meets the requirements of para. 632 shall require <i>multilateral approval</i>. After 31 December 2003, each <i>design</i> that meets the requirements of paras 629–631 shall</p>	<p>805. The approval of <i>designs</i> for <i>packages</i> containing 0.1 kg or more of uranium hexafluoride requires that:</p> <p>(a) After 31 December 2000, each <i>design</i> that meets the requirements of para. 632 or contains fissile material shall require <i>multilateral approval</i>. After 31 December 2003, each <i>design</i> that meets the</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
45	UK/02/41 and UK/02/58	806	<p>require <i>unilateral approval</i> by the <i>competent authority</i> of the country of origin of the <i>design</i>;</p> <p>(b) The application for approval shall include all information necessary to satisfy the <i>competent authority</i> that the <i>design</i> meets the requirements of para. 629, and a specification of the applicable <i>quality assurance</i> programme as required in para. 310;</p> <p>(c) The <i>competent authority</i> shall establish an approval certificate stating that the approved <i>design</i> meets the requirements of para. 629 and shall attribute to that <i>design</i> an identification mark.</p>	<p>requirements of paras 629–631, except for those containing fissile material, shall require <i>unilateral approval</i> by the <i>competent authority</i> of the country of origin of the <i>design</i>;</p> <p>(b) The application for approval shall include all information necessary to satisfy the <i>competent authority</i> that the <i>design</i> meets the requirements of para. 629, and a specification of the applicable <i>quality assurance</i> programme as required in para. 310;</p> <p>(c) The <i>competent authority</i> shall establish an approval certificate stating that the approved <i>design</i> meets the requirements of para. 629 and shall attribute to that <i>design</i> an identification mark.</p>
46	UK/02/52	806	<p>806. Each <i>Type B(U)</i> and <i>Type C package design</i> shall require <i>unilateral approval</i>, except that:</p> <p>(a) a <i>package design</i> for <i>fissile material</i>, which is also subject to paras 812–814, shall require <i>multilateral approval</i>; and</p> <p>(b) a <i>Type B(U) package design</i> for <i>low dispersible radioactive material</i> shall require <i>multilateral approval</i>.</p>	<p>806. Each <i>Type B(U)</i> and <i>Type C package design</i> shall require <i>unilateral approval</i>, except that:</p> <p>(a) a <i>package design</i> for <i>fissile material</i>, which is also subject to paras 812–814, shall require <i>multilateral approval</i>; and</p> <p>(b) a <i>Type B(U) package design</i> for <i>low dispersible radioactive material</i> shall require <i>multilateral approval for carriage by air</i>.</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
48	UK/02/39 (2 of 4) see #43	815	<p>Packages not requiring competent authority approval of design under the 1985 and 1985 (As Amended 1990) Editions of these Regulations</p> <p>815. <i>Excepted packages, Type IP-1, Type IP-2 and Type IP-3 and Type A packages</i> that did not require <i>approval of design</i> by the <i>competent authority</i> and which meet the requirements of the 1985 or 1985 (As Amended 1990) Editions of these Regulations may continue to be used subject to the mandatory programme of <i>quality assurance</i> in accordance with the requirements of para. 310 and the activity limits and material restrictions of Section IV. Any <i>packaging</i> - modified, unless to improve safety, or manufactured after 31 December 2003, shall meet this Edition of the Regulations in full. <i>Packages</i> prepared for transport not later than 31 December 2003 under the 1985 or 1985 (As</p>	<p>(e) if the radionuclide is a noble gas, the effective dose coefficient for submersion dose (Sv.Bq-1.s-1.m3); and</p> <p>(f) the calculated values for A1 and A2 in TBq, the activity concentration for exempt material in Bq/g; and the activity limits for exempt <i>consignments</i> in Bq.</p> <p>814bis+2. The <i>competent authority</i> shall establish an approval stating that the calculated radionuclide values are approved.</p> <p>Packages not requiring competent authority approval of design under the 1985 and 1985 (As Amended 1990) Editions of these Regulations</p> <p>815. <i>Excepted packages, Type IP-1, Type IP-2 and Type IP-3 and Type A packages</i> that did not require <i>approval of design</i> by the <i>competent authority</i> and which meet the requirements of the 1985 or 1985 (As Amended 1990) Editions of these Regulations may continue to be used subject to the mandatory programme of <i>quality assurance</i> in accordance with the requirements of para. 310 and the activity limits and material restrictions of Section IV. Any <i>packaging</i> modified, unless to improve safety, or manufactured, shall meet this Edition of the Regulations in full. <i>Packages</i> prepared for transport not later than 31 December 2003 under the 1985 or 1985 (As Amended 1990)</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
49	UK/02/39 (3 of 4) see #43	817	<p>Amended 1990) Editions of these Regulations may continue in transport. <i>Packages</i> prepared for transport after this date shall meet this Edition of the Regulations in full.</p> <p>Packages approved under the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) Editions of these Regulations</p> <p>817. <i>Packagings</i> manufactured to a <i>package design</i> approved by the <i>competent authority</i> under the provisions of the 1985 or 1985 (As Amended 1990) Editions of these Regulations may continue to be used until 31 December 2003, subject to: the mandatory programme of <i>quality assurance</i> in accordance with the requirements of para. 310; the activity limits and material restrictions of Section IV; and, for a <i>package</i> containing <i>fissile material</i> and transported by air, the requirement of para. 680. After this date use may continue subject, additionally, to multilateral approval of package design. Changes in the <i>design</i> of the <i>packaging</i> or in the nature or quantity of the authorized <i>radioactive contents</i> which, as determined by the <i>competent authority</i>, would significantly affect safety shall require that this Edition of the Regulations be met in full. All <i>packagings</i> for which manufacture begins after 31 December 2006 shall meet this Edition of the Regulations in full.</p>	<p>Editions of these Regulations may continue in transport. <i>Packages</i> prepared for transport after this date shall meet this Edition of the Regulations in full.</p> <p>Packages approved under the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) Editions of these Regulations</p> <p>817. <i>Packagings</i> manufactured to a <i>package design</i> approved by the <i>competent authority</i> under the provisions of the 1985 or 1985 (As Amended 1990) Editions of these Regulations may continue to be used, subject to: multilateral approval of package design, the mandatory programme of <i>quality assurance</i> in accordance with the requirements of para. 310; the activity limits and material restrictions of Section IV; and, for a <i>package</i> containing <i>fissile material</i> and transported by air, the requirement of para. 680. Changes in the <i>design</i> of the <i>packaging</i> or in the nature or quantity of the authorized <i>radioactive contents</i> which, as determined by the <i>competent authority</i>, would significantly affect safety shall require that this Edition of the Regulations be met in full. All <i>packagings</i> for which manufacture begins after 31 December 2006 shall meet this Edition of the Regulations in full.</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
50	UK/02/39 (4 of 4) <i>see</i> #43	818	Special form radioactive material approved under the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) Editions of these Regulations 818. <i>Special form radioactive material manufactured to a design which had received unilateral approval by the competent authority under the 1973, 1973 (As Amended), 1985 or 1985 (As Amended 1990) Editions of these Regulations may continue to be used when in compliance with the mandatory programme of quality assurance in accordance with the applicable requirements of para. 310. All special form radioactive material manufactured after 31 December 2003 shall meet this Edition of the Regulations in full.</i>	Special form radioactive material approved under the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) Editions of these Regulations 818. <i>Special form radioactive material manufactured to a design which had received unilateral approval by the competent authority under the 1973, 1973 (As Amended), 1985 or 1985 (As Amended 1990) Editions of these Regulations may continue to be used when in compliance with the mandatory programme of quality assurance in accordance with the applicable requirements of para. 310. All special form radioactive material manufactured shall meet this Edition of the Regulations in full.</i>
51	France/02/42	815/818	See Appendix 3	See Appendix 3
52	UK/02/43	819	819. The <i>competent authority</i> shall be informed of the serial number of each - <i>packaging</i> manufactured to a <i>design</i> approved under paras 806, 809, 812, and 816-817. The competent authority should, consistent with para. 311, maintain a register of such serial numbers.	819. The <i>competent authority</i> shall be informed of the serial number of each - <i>packaging</i> manufactured to a <i>design</i> approved under paras 806, 809, 812, and 816-817
53	Canada/02/12 (5 of 6) <i>see</i> #6	819	819. The <i>competent authority</i> shall be informed of the serial number of each - <i>packaging</i> manufactured to a <i>design</i> approved	819. The <i>competent authority</i> shall be informed of the serial number of each - <i>packaging</i> manufactured to a <i>design</i> approved

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
54	Germany/02/02	820	<p>under paras 806, 809, 812, and 816–817. The <i>competent authority</i> should, consistent with para. 311, maintain a register of such serial numbers.</p> <p>820. <i>Multilateral approval</i> shall be required for:</p> <p>(a) the <i>shipment of Type B(M) packages</i> not conforming with the requirements of para. 637 or designed to allow controlled intermittent venting;</p> <p>(b) the <i>shipment of Type B(M) packages</i> containing <i>radioactive material</i> with an activity greater than 3000 A_1 or 3000 A_2, as appropriate, or 1000 TBq, whichever is the lower;</p> <p>(c) the <i>shipment of packages</i> containing <i>fissile materials</i> if the sum of the <i>criticality safety indexes</i> of the <i>packages</i> exceeds 50; and</p> <p>(d) <i>radiation protection programmes</i> for <i>shipments</i> by special use vessels according to para. 575(a).</p>	<p>under paras 805, 806, 809, 812, and 816–817. The <i>competent authority</i> should, consistent with para. 311, maintain a register of such serial numbers.</p> <p>820. <i>Multilateral approval</i> shall be required for:</p> <p>(a) the <i>shipment of Type B(M) packages</i> not conforming with the requirements of para. 637 or designed to allow controlled intermittent venting;</p> <p>(b) the <i>shipment of Type B(M) packages</i> containing <i>radioactive material</i> with an activity greater than 3000 A_1 or 3000 A_2, as appropriate, or 1000 TBq, whichever is the lower;</p> <p>(c) the <i>shipment of packages</i> containing <i>fissile materials</i> if the sum of the <i>criticality safety indexes</i> of the <i>packages in a freight container or in any group aboard a conveyance</i> exceeds 50 as provided in para 566 (d); and</p> <p>(d) <i>radiation protection programmes</i> for <i>shipments</i> by special use vessels according to para. 575(a).</p>
55	UK/02/45	824	<p>824. Each <i>consignment</i> transported internationally under <i>special arrangement</i> shall require <i>multilateral approval</i>.</p>	<p>824. Each <i>consignment</i> transported under <i>special arrangement</i> shall require <i>multilateral approval</i>.</p>
56	Canada/02/12 (6)	833	<p>833. Each approval certificate of the <i>design</i></p>	<p>833. Each approval certificate of the <i>design</i></p>

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Change	Proposal of 6) see #6	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>of a <i>package</i> issued by a <i>competent authority</i> shall include the following information:</p> <p>(a) Type of certificate. (b) The <i>competent authority</i> identification mark. (c) The issue date and an expiry date. (d) Any restriction on the modes of transport, if appropriate. (e) List of applicable national and international regulations, including the edition of the IAEA Regulations for the Safe Transport of Radioactive Material under which the <i>design</i> is approved. (f) The following statement: “This certificate does not relieve the consignor from compliance with any requirement of the government of any country through or into which the package will be transported.” (g) References to certificates for alternative <i>radioactive contents</i>, other <i>competent authority</i> validation, or additional technical data or information, as deemed appropriate by the <i>competent authority</i>. (h) A statement authorizing <i>shipment</i> where <i>shipment</i> approval is required under para. 820, if deemed appropriate. (i) Identification of the <i>packaging</i>. (j) Description of the <i>packaging</i> by a reference to the drawings or specification</p>	<p>of a <i>package</i> issued by a <i>competent authority</i> shall include the following information:</p> <p>(a) Type of certificate. (b) The <i>competent authority</i> identification mark. (c) The issue date and an expiry date. (d) Any restriction on the modes of transport, if appropriate. (e) List of applicable national and international regulations, including the edition of the IAEA Regulations for the Safe Transport of Radioactive Material under which the <i>design</i> is approved. (f) The following statement: “This certificate does not relieve the consignor from compliance with any requirement of the government of any country through or into which the package will be transported.” (g) References to certificates for alternative <i>radioactive contents</i>, other <i>competent authority</i> validation, or additional technical data or information, as deemed appropriate by the <i>competent authority</i>. (h) A statement authorizing <i>shipment</i> where <i>shipment</i> approval is required under para. 820, if deemed appropriate. (i) Identification of the <i>packaging</i>. (j) Description of the <i>packaging</i> by a reference to the drawings or specification</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>of the <i>design</i>. If deemed appropriate by the <i>competent authority</i>, a reproducible illustration, not larger than 21 cm by 30 cm, showing the make-up of the <i>package</i> should also be provided, accompanied by a brief description of the <i>packaging</i>, including materials of manufacture, gross mass, general outside dimensions and appearance.</p> <p>(k) Specification of the <i>design</i> by reference to the drawings.</p> <p>(l) A specification of the authorized <i>radioactive content</i>, including any restrictions on the <i>radioactive contents</i> which might not be obvious from the nature of the <i>packaging</i>. This shall include the physical and chemical forms, the activities involved (including those of the various isotopes, if appropriate), amounts in grams (for <i>fissile material</i>), and whether <i>special form radioactive material</i> or <i>low dispersible radioactive material</i>, if applicable.</p> <p>(m) Additionally, for <i>packages</i> containing <i>fissile material</i>:</p> <p>(i) a detailed description of the authorized <i>radioactive contents</i>;</p> <p>(ii) the value of the <i>criticality safety index</i>;</p> <p>(iii) reference to the documentation that demonstrates the criticality safety of</p>	<p>of the <i>design</i>. If deemed appropriate by the <i>competent authority</i>, a reproducible illustration, not larger than 21 cm by 30 cm, showing the make-up of the <i>package</i> should also be provided, accompanied by a brief description of the <i>packaging</i>, including materials of manufacture, gross mass, general outside dimensions and appearance.</p> <p>(k) Specification of the <i>design</i> by reference to the drawings.</p> <p>(l) A specification of the authorized <i>radioactive content</i>, including any restrictions on the <i>radioactive contents</i> which might not be obvious from the nature of the <i>packaging</i>. This shall include the physical and chemical forms, the activities involved (including those of the various isotopes, if appropriate), amounts in grams (for <i>fissile material</i>), and whether <i>special form radioactive material</i> or <i>low dispersible radioactive material</i>, if applicable.</p> <p>(m) Additionally, for <i>packages</i> containing <i>fissile material</i>:</p> <p>(i) a detailed description of the authorized <i>radioactive contents</i>;</p> <p>(ii) the value of the <i>criticality safety index</i>;</p> <p>(iii) reference to the documentation that demonstrates the criticality safety of</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>the contents;</p> <p>(iv) any special features, on the basis of which the absence of water from - certain void spaces has been assumed in the criticality assessment;</p> <p>(v) any allowance (based on para. 674(b)) for a change in neutron - multiplication assumed in the criticality assessment as a result of actual irradiation experience; and</p> <p>(vi) the ambient temperature range for which the <i>package design</i> has been approved.</p> <p>(n) For <i>Type B(M) packages</i>, a statement specifying those prescriptions of paras 637, 653, 654 and 657-664 with which the <i>package</i> does not conform and any amplifying information which may be useful to other <i>competent authorities</i>.</p> <p>(o) A detailed listing of any supplementary operational controls required for preparation, loading, carriage, unloading and handling of the <i>consignment</i>, including any special stowage provisions</p>	<p>the contents;</p> <p>(iv) any special features, on the basis of which the absence of water from - certain void spaces has been assumed in the criticality assessment;</p> <p>(v) any allowance (based on para. 674(b)) for a change in neutron - multiplication assumed in the criticality assessment as a result of actual irradiation experience; and</p> <p>(vi) the ambient temperature range for which the <i>package design</i> has been approved.</p> <p>(n) For <i>Type B(M) packages</i>, a statement specifying those prescriptions of paras 637, 653, 654 and 657-664 with which the <i>package</i> does not conform and any amplifying information which may be useful to other <i>competent authorities</i>.</p> <p>(n) (bis) For <i>packages</i> containing more than 0.1 kg of uranium hexafluoride, a statement specifying those prescriptions of paras 630 and 631 with which the <i>package</i> does not conform and any amplifying information which may be useful to other competent authorities.”</p> <p>(o) A detailed listing of any supplementary operational controls required for preparation, loading, carriage, unloading and handling of the <i>consignment</i>, including any special stowage provisions</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>for the safe dissipation of heat.</p> <p>(p) Reference to information provided by the applicant relating to the use of the <i>packaging</i> or specific actions to be taken prior to <i>shipment</i>.</p> <p>(q) A statement regarding the ambient conditions assumed for purposes of <i>design</i> if these are not in accordance with those specified in paras 653, 654 and 664, as applicable.</p> <p>(r) A specification of the applicable <i>quality assurance</i> programme as required in para. 310.</p> <p>(s) Any emergency arrangements deemed necessary by the <i>competent authority</i>.</p> <p>(t) If deemed appropriate by the <i>competent authority</i>, reference to the identity of the applicant.</p> <p>(u) Signature and identification of the certifying official.</p>	<p>for the safe dissipation of heat.</p> <p>(p) Reference to information provided by the applicant relating to the use of the <i>packaging</i> or specific actions to be taken prior to <i>shipment</i>.</p> <p>(q) A statement regarding the ambient conditions assumed for purposes of <i>design</i> if these are not in accordance with those specified in paras 653, 654 and 664, as applicable.</p> <p>(r) A specification of the applicable <i>quality assurance</i> programme as required in para. 310.</p> <p>(s) Any emergency arrangements deemed necessary by the <i>competent authority</i>.</p> <p>(t) If deemed appropriate by the <i>competent authority</i>, reference to the identity of the applicant.</p> <p>(u) Signature and identification of the certifying official.</p>
57	Sweden/02/07	833	<p>833. Each approval certificate of the <i>design</i> of a <i>package</i> issued by a <i>competent authority</i> shall include the following information:</p> <p>(a) Type of certificate.</p> <p>(b) The <i>competent authority</i> identification mark.</p> <p>(c) The issue date and an expiry date.</p> <p>(d) Any restriction on the modes of transport, if appropriate.</p>	<p>833. Each approval certificate of the <i>design</i> of a <i>package</i> issued by a <i>competent authority</i> shall include the following information:</p> <p>(a) Type of certificate.</p> <p>(b) The <i>competent authority</i> identification mark.</p> <p>(c) The issue date and an expiry date.</p> <p>(d) Any restriction on the modes of transport, if appropriate.</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>(e) List of applicable national and international regulations, including the edition of the IAEA Regulations for the Safe Transport of Radioactive Material under which the <i>design</i> is approved.</p> <p>(f) The following statement: “This certificate does not relieve the consignor from compliance with any requirement of the government of any country through or into which the package will be transported.”</p> <p>(g) References to certificates for alternative <i>radioactive contents</i>, other <i>competent authority</i> validation, or additional technical data or information, as deemed appropriate by the <i>competent authority</i>.</p> <p>(h) A statement authorizing <i>shipment</i> where <i>shipment</i> approval is required under para. 820, if deemed appropriate.</p> <p>(i) Identification of the <i>packaging</i>.</p> <p>(j) Description of the <i>packaging</i> by a reference to the drawings or specification of the <i>design</i>. If deemed appropriate by the <i>competent authority</i>, a reproducible illustration, not larger than 21 cm by 30 cm, showing the make-up of the <i>package</i> should also be provided, accompanied by a brief description of the <i>packaging</i>, including materials of manufacture, gross mass, general outside dimensions and appearance.</p>	<p>(e) List of applicable national and international regulations, including the edition of the IAEA Regulations for the Safe Transport of Radioactive Material under which the <i>design</i> is approved.</p> <p>(f) The following statement: “This certificate does not relieve the consignor from compliance with any requirement of the government of any country through or into which the package will be transported.”</p> <p>(g) References to certificates for alternative <i>radioactive contents</i>, other <i>competent authority</i> validation, or additional technical data or information, as deemed appropriate by the <i>competent authority</i>.</p> <p>(h) A statement authorizing <i>shipment</i> where <i>shipment</i> approval is required under para. 820, if deemed appropriate.</p> <p>(i) Identification of the <i>packaging</i>.</p> <p>(j) Description of the <i>packaging</i> by a reference to the drawings or specification of the <i>design</i>. If deemed appropriate by the <i>competent authority</i>, a reproducible illustration, not larger than 21 cm by 30 cm, showing the make-up of the <i>package</i> should also be provided, accompanied by a brief description of the <i>packaging</i>, including materials of manufacture, gross mass, general outside dimensions and appearance.</p>

Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>(k) Specification of the <i>design</i> by reference to the drawings.</p> <p>(l) A specification of the authorized <i>radioactive content</i>, including any restrictions on the <i>radioactive contents</i> which might not be obvious from the nature of the <i>packaging</i>. This shall include the physical and chemical forms, the activities involved (including those of the various isotopes, if appropriate), amounts in grams (for <i>fissile material</i>), and whether <i>special form radioactive material</i> or <i>low dispersible radioactive material</i>, if applicable.</p> <p>(m) Additionally, for <i>packages</i> containing <i>fissile material</i>:</p> <p>(i) a detailed description of the authorized <i>radioactive contents</i>;</p> <p>(ii) the value of the <i>criticality safety index</i>;</p> <p>(iii) reference to the documentation that demonstrates the criticality safety of the contents;</p> <p>(iv) any special features, on the basis of which the absence of water from - certain void spaces has been assumed</p>	<p>(j bis) Description(s) of the <i>containment system</i> (para. 213) and, for packages containing fissile material that are not excepted by para. 672, the <i>confinement system</i> (para. 209)</p> <p>(k) Specification of the <i>design</i> by reference to the drawings.</p> <p>(l) A specification of the authorized <i>radioactive content</i>, including any restrictions on the <i>radioactive contents</i> which might not be obvious from the nature of the <i>packaging</i>. This shall include the physical and chemical forms, the activities involved (including those of the various isotopes, if appropriate), amounts in grams (for <i>fissile material</i>), and whether <i>special form radioactive material</i> or <i>low dispersible radioactive material</i>, if applicable.</p> <p>(m) Additionally, for <i>packages</i> containing <i>fissile material</i>:</p> <p>(i) a detailed description of the authorized <i>radioactive contents</i>;</p> <p>(ii) the value of the <i>criticality safety index</i>;</p> <p>(iii) reference to the documentation that demonstrates the criticality safety of the contents;</p> <p>(iv) any special features, on the basis of which the absence of water from - certain void spaces has been assumed</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>in the criticality assessment;</p> <p>(v) any allowance (based on para. 674(b)) for a change in neutron - multiplication assumed in the criticality assessment as a result of actual irradiation experience; and</p> <p>(vi) the ambient temperature range for which the <i>package design</i> has been approved.</p> <p>(n) For <i>Type B(M) packages</i>, a statement specifying those prescriptions of paras 637, 653, 654 and 657-664 with which the <i>package</i> does not conform and any amplifying information which may be useful to other <i>competent authorities</i>.</p> <p>(o) A detailed listing of any supplementary operational controls required for preparation, loading, carriage, unloading and handling of the <i>consignment</i>, including any special stowage provisions for the safe dissipation of heat.</p> <p>(p) Reference to information provided by the applicant relating to the use of the <i>packaging</i> or specific actions to be taken prior to <i>shipment</i>.</p> <p>(q) A statement regarding the ambient conditions assumed for purposes of <i>design</i> if these are not in accordance with those specified in paras 653, 654 and 664, as applicable.</p> <p>(r) A specification of the applicable <i>quality</i></p>	<p>in the criticality assessment;</p> <p>(v) any allowance (based on para. 674(b)) for a change in neutron - multiplication assumed in the criticality assessment as a result of actual irradiation experience; and</p> <p>(vi) the ambient temperature range for which the <i>package design</i> has been approved.</p> <p>(n) For <i>Type B(M) packages</i>, a statement specifying those prescriptions of paras 637, 653, 654 and 657-664 with which the <i>package</i> does not conform and any amplifying information which may be useful to other <i>competent authorities</i>.</p> <p>(o) A detailed listing of any supplementary operational controls required for preparation, loading, carriage, unloading and handling of the <i>consignment</i>, including any special stowage provisions for the safe dissipation of heat.</p> <p>(p) Reference to information provided by the applicant relating to the use of the <i>packaging</i> or specific actions to be taken prior to <i>shipment</i>.</p> <p>(q) A statement regarding the ambient conditions assumed for purposes of <i>design</i> if these are not in accordance with those specified in paras 653, 654 and 664, as applicable.</p> <p>(r) A specification of the applicable <i>quality</i></p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
58	UK/02/64	834bis	<p><i>assurance</i> programme as required in para. 310.</p> <p>(s) Any emergency arrangements deemed necessary by the <i>competent authority</i>.</p> <p>(t) If deemed appropriate by the <i>competent authority</i>, reference to the identity of the applicant.</p> <p>(u) Signature and identification of the certifying official.</p> <p>No existing text</p>	<p><i>assurance</i> programme as required in para. 310.</p> <p>(s) Any emergency arrangements deemed necessary by the <i>competent authority</i>.</p> <p>(t) If deemed appropriate by the <i>competent authority</i>, reference to the identity of the applicant.</p> <p>(u) Signature and identification of the certifying official.</p>
				<p>834bis. Change(s) to a <i>design</i>, as defined in para 802, for which <i>competent authority approval(s)</i> exist may be approved depending upon their effects upon safety without affecting the validity of the existing <i>package approval</i>. Each change shall include a statement as to its effects upon the nuclear safety of the <i>radioactive contents</i> of the <i>package</i>.</p> <p>(a) In the first instance the change(s) shall be submitted to the <i>competent authority</i> of the country of origin of the <i>design</i> for <i>approval</i>.</p> <p>(b) All changes that effect the nuclear safety of the <i>radioactive contents</i> of a <i>package</i> shall require <i>multilateral approval</i>.</p> <p>(c) The relevant <i>competent authority</i> both of the country of origin of the <i>design</i> or shipment and of each country through</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
59	Canada/02/04 (2 of 2) see #20	Schedules		<p>or into which the <i>consignment</i> is to be transported, as defined in para 204, shall be notified of all changes.</p>
				<p>Placarding provisions outlined in Part 9 of Schedule 5, 6, 7, and 9 in the case of Uranium Hexafluoride</p> <p>Schedule 5, Part 9(b) bis For unpackaged LSA-1.....shown in the Fig. 7. However, if the packages contain non-fissile or fissile-excepted uranium hexafluoride, "2978" shall be displayed. For the placards shown in Fig. 6, the numbers shall be preceded by the letters "UN".</p> <p>Schedule 6, Part 9(b) bis. Where an exclusive use "3324" shall be displayed on the placards.</p> <p>However, if the packages contain non-fissile or fissile-excepted uranium hexafluoride, "2978" shall be displayed. If the packages contain uranium hexafluoride that is fissile material, "2977" shall be displayed. For the placards shown in Fig. 6, the numbers shall be preceded by the letters "UN".</p> <p>Schedule 7, Part 9(b) bis. Where an exclusive use "3325" shall be displayed on the placards.</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
60	UK/02/30	622 (alternate proposal B) and consequential changes in 624, 625, 627, 628 and 646	<p>622. A <i>package</i>, to be qualified as a <i>Type IP-2</i>, shall be designed to meet the requirements for <i>Type IP-1</i> as specified in para. 621 and, in addition, if it were subjected to the tests specified in paras 722 and 723, it would - prevent:</p> <p>(a) loss or dispersal of the <i>radioactive contents</i>; and</p> <p>(b) loss of shielding integrity which would result in more than a 20% increase in the radiation level at any external surface of</p>	<p>However, if the packages contain non-fissile or fissile-excepted uranium hexafluoride, "2978" shall be displayed. If the packages contain uranium hexafluoride that is fissile material, "2977" shall be displayed. For the placards shown in Fig. 6, the numbers shall be preceded by the letters "UN".</p> <p>Schedule 9, Part 9(c) bis. Where an exclusive use "3327" shall be displayed on the placards.</p> <p>However, if the Type A packages contain non-fissile or fissile-excepted uranium hexafluoride, "2978" shall be displayed. If the Type A packages contain uranium hexafluoride that is fissile material, "2977" shall be displayed. For the placards shown in Fig. 6, the numbers shall be preceded by the letters "UN".</p>
			<p>(a) loss or dispersal of the <i>radioactive contents</i>; and</p> <p>(b) more than a 20% increase in the <i>transport index</i> of the <i>package</i>; and</p> <p>(c) an increase in the radiation level at any</p>	

Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>the <i>package</i>.</p> <p>624. <i>Packages</i> may be used as <i>Type IP-2</i> provided that:</p> <p>(a) They satisfy the requirements for <i>Type IP-1</i> specified in para. 621;</p> <p>(b) They are designed to conform to the standards prescribed in the chapter on General Recommendations on Packing of the United Nations Recommendations on the Transport of Dangerous Goods [7], or other requirements at least equivalent to those standards; and</p> <p>(c) When subjected to the tests required for UN Packing Group I or II, they would prevent:</p> <p>(i) loss or dispersal of the <i>radioactive contents</i>; and</p> <p>(ii) loss of shielding integrity which would result in more than a 20% increase in the radiation level at any external surface of the package.</p>	<p>external surface of the package to a level 20% above the maximum specified in column 2 of Table VII for the category of package, based on the maximum <i>radioactive contents</i> which the <i>package</i> is designed to contain.</p> <p>624. <i>Packages</i> may be used as <i>Type IP-2</i> provided that:</p> <p>(a) They satisfy the requirements for <i>Type IP-1</i> specified in para. 621;</p> <p>(b) They are designed to conform to the standards prescribed in the chapter on General Recommendations on Packing of the United Nations Recommendations on the Transport of Dangerous Goods [7], or other requirements at least equivalent to those standards; and</p> <p>(c) When subjected to the tests required for UN Packing Group I or II, they would prevent:</p> <p>(i) loss or dispersal of the <i>radioactive contents</i>;</p> <p>(ii) more than a 20% increase in the <i>transport index</i> of the <i>package</i>; and</p> <p>(iii) an increase in the radiation level at any external surface of the package to a level 20% above the maximum specified in column 2 of Table VII for the category of package, based on the maximum</p>

Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>625. Tank containers may also be used as <i>Type IP-2</i> or <i>Type IP-3</i>, provided that:</p> <p>(a) They satisfy the requirements for <i>Type IP-1</i> specified in para. 621;</p> <p>(b) They are designed to conform to the standards prescribed in the chapter on Recommendations on Multimodal Tank Transport of the United Nations Recommendations on the Transport of Dangerous Goods [7], or other - requirements at least equivalent to those standards, and are capable of withstanding a test pressure of 265 kPa; and</p> <p>(c) They are designed so that any additional shielding which is provided shall be capable of withstanding the static and dynamic stresses resulting from handling and routine conditions of transport and of preventing a loss of shielding integrity which would result in more than a 20% increase in the <i>radiation level</i> at any external surface of the tank containers.</p>	<p><i>radioactive contents</i> which the package is designed to contain.</p> <p>625. Tank containers may also be used as <i>Type IP-2</i> or <i>Type IP-3</i>, provided that:</p> <p>(a) They satisfy the requirements for <i>Type IP-1</i> specified in para. 621;</p> <p>(b) They are designed to conform to the standards prescribed in the chapter on Recommendations on Multimodal Tank Transport of the United Nations Recommendations on the Transport of Dangerous Goods [7], or other - requirements at least equivalent to those standards, and are capable of withstanding a test pressure of 265 kPa; and</p> <p>(c) They are designed so that any additional shielding which is provided shall be capable of withstanding the static and dynamic stresses resulting from handling and routine conditions of transport and of preventing:</p> <p>(i) more than a 20% increase in the <i>transport index</i> of the tank container; and</p> <p>(ii) an increase in the radiation level at any external surface of the tank container to a level 20% above the maximum specified in column 2 of Table VII for the category of tank</p>

Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>627. <i>Freight containers</i> may also be used as <i>Type IP-2</i> or <i>Type IP-3</i>, provided that:</p> <p>(a) The <i>radioactive contents</i> are restricted to solid materials;</p> <p>(b) They satisfy the requirements for <i>Type IP-1</i> specified in para. 621; and</p> <p>(c) They are designed to conform to the standards prescribed in the International Organization for Standardization document ISO 1496/1: “Series 1 Freight Containers — Specifications and Testing — Part 1: General Cargo Containers” [9] excluding dimensions and ratings. They shall be designed such that if subjected to the tests prescribed in that document and the accelerations occurring during routine conditions of transport they would - prevent:</p> <p>(i) loss or dispersal of the <i>radioactive contents</i>; and</p> <p>(ii) loss of shielding integrity which would result in more than a 20% increase in the radiation level at any external surface of the freight -</p>	<p>container, based on the maximum radioactive contents which the tank container is designed to contain.</p> <p>627. <i>Freight containers</i> may also be used as <i>Type IP-2</i> or <i>Type IP-3</i>, provided that:</p> <p>(a) The <i>radioactive contents</i> are restricted to solid materials;</p> <p>(b) They satisfy the requirements for <i>Type IP-1</i> specified in para. 621; and</p> <p>(c) They are designed to conform to the standards prescribed in the International Organization for Standardization document ISO 1496/1: “Series 1 Freight Containers — Specifications and Testing — Part 1: General Cargo Containers” [9] excluding dimensions and ratings. They shall be designed such that if subjected to the tests prescribed in that document and the accelerations occurring during routine conditions of transport they would - prevent:</p> <p>(i) loss or dispersal of the <i>radioactive contents</i>; and</p> <p>(ii) more than a 20% increase in the transport index of the freight container; and</p> <p>(iii) an increase in the radiation level at</p>

Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p><i>containers.</i></p> <p>628. Metal <i>intermediate bulk containers</i> may also be used as <i>Type IP-2</i> or <i>Type IP-3</i>, provided that:</p> <p>(a) They satisfy the requirements for <i>Type IP-1</i> specified in para. 621; and</p> <p>(b) They are designed to conform to the standards prescribed in the chapter on Recommendations on Intermediate Bulk Containers (IBC's) of the United Nations Recommendations on the Transport of Dangerous Goods [7], for Packing Group I or II, and if they were subjected to the tests prescribed in that document, but with the drop test conducted in the most damaging orientation, they would prevent:</p> <p>(i) loss or dispersal of the <i>radioactive contents</i>; and</p> <p>(ii) loss of shielding integrity which would result in more than a 20% increase in the <i>radiation level</i> at any external surface of the <i>intermediate</i></p>	<p>any external surface of the freight container to a level 20% above the maximum specified in column 2 of Table VII for the category of freight container, based on the maximum radioactive contents which the freight container is designed to contain.</p> <p>628. Metal <i>intermediate bulk containers</i> may also be used as <i>Type IP-2</i> or <i>Type IP-3</i>, provided that:</p> <p>(a) They satisfy the requirements for <i>Type IP-1</i> specified in para. 621; and</p> <p>(b) They are designed to conform to the standards prescribed in the chapter on Recommendations on Intermediate Bulk Containers (IBC's) of the United Nations Recommendations on the Transport of Dangerous Goods [7], for Packing Group I or II, and if they were subjected to the tests prescribed in that document, but with the drop test conducted in the most damaging orientation, they would prevent:</p> <p>(i) loss or dispersal of the <i>radioactive contents</i>;</p> <p>(ii) more than a 20% increase in the <i>transport index</i> for the intermediate bulk container; and</p> <p>(iii) an increase in the radiation level at</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
61	UK/02/74 UK/02/14 UK/02/60 UKRAINE/02/01 UK/02/72	106, 107, 220bis, 301- 315 (partly paragraph reordering),	<p><i>bulk container.</i></p> <p>646. A <i>package</i> shall be so designed that if it were subjected to the tests specified in paras 719–724, it would prevent:</p> <p>(a) Loss or dispersal of the <i>radioactive contents</i>; and</p> <p>(b) Loss of shielding integrity which would result in more than a 20% increase in the <i>radiation level</i> at any external surface of the <i>package</i>.</p>	<p>any external surface of the intermediate bulk container to a level 20% above the maximum specified in column 2 of Table VII for the category of intermediate bulk container, based on the maximum radioactive contents which the intermediate bulk container is designed to contain.</p> <p>646. A <i>package</i> shall be so designed that if it were subjected to the tests specified in paras 719–724, it would prevent:</p> <p>(a) Loss or dispersal of the <i>radioactive contents</i>; and</p> <p>(b) more than a 20% increase in the <i>transport index</i> of the package; and</p> <p>(c) an increase in the radiation level at any external surface of the package to a level 20% above the maximum specified in column 2 of Table VII for the category of package, based on the maximum radioactive contents which the package is designed to contain.</p>
		See Appendix 4		See Appendix 4

Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
62	France/02/09, UK/02/61, UK/02/62, Canada/02/04, France/02/16, WNTI/02/01, WNTI/02/04 and WNTI/02/08	562 533, 533bis, 549	<p>533. <i>Packages</i> and <i>overpacks</i> shall be assigned to either category I-WHITE, II-YELLOW or III-YELLOW in accordance with the conditions specified in Table VII and with the following requirements:</p> <p>(a) For a <i>package</i> or <i>overpack</i>, both the <i>transport index</i> and the surface <i>radiation level</i> conditions shall be taken into account in determining which is the appropriate category. Where the <i>transport index</i> satisfies the condition for one category but the surface <i>radiation level</i> satisfies the condition for a different category, the <i>package</i> or <i>overpack</i> shall be assigned to the higher category. For this purpose, category I-WHITE shall be regarded as the lowest category.</p> <p>(b) The <i>transport index</i> shall be determined following the procedures specified in paras 526 and 527.</p> <p>(c) If the surface <i>radiation level</i> is greater than 2 mSv/h, the <i>package</i> or <i>overpack</i> shall be transported under <i>exclusive use</i> and under the provisions of paras 572(a), 574 or 578, as appropriate.</p> <p>(d) A <i>package</i> transported under a <i>special arrangement</i> shall be assigned to category III-YELLOW.</p>	<p>533. <i>Packages</i> and <i>overpacks</i> shall be assigned to either category I-WHITE, II-YELLOW or III-YELLOW in accordance with the conditions specified in Table VII and with the following requirements:</p> <p>(a) For a <i>package</i> or <i>overpack</i>, both the <i>transport index</i> and the surface <i>radiation level</i> conditions shall be taken into account in determining which is the appropriate category. Where the <i>transport index</i> satisfies the condition for one category but the surface <i>radiation level</i> satisfies the condition for a different category, the <i>package</i> or <i>overpack</i> shall be assigned to the higher category. For this purpose, category I-WHITE shall be regarded as the lowest category.</p> <p>(b) The <i>transport index</i> shall be determined following the procedures specified in paras 526 and 527.</p> <p>(c) If the surface <i>radiation level</i> is greater than 2 mSv/h, the <i>package</i> or <i>overpack</i> shall be transported under <i>exclusive use</i> and under the provisions of paras 572(a), 574 or 578, as appropriate.</p> <p>(d) A <i>package</i> transported under a <i>special arrangement</i> shall be assigned to category III-YELLOW except under the provisions of para 533bis.</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>(e) An <i>overpack</i> which contains <i>packages transported under special arrangement</i> shall be assigned to category III-YELLOW.</p>	<p>(e) An <i>overpack</i> which contains <i>packages transported under special arrangement</i> shall be assigned to category III-YELLOW except under the provisions of para 533bis.</p> <p>MARKING, LABELLING AND PLACARDING</p> <p>533bis. For each package the UN number and proper shipping name shall be determined (see table VIII). In all cases of international transport of packages requiring competent authority design or shipment approval, for which different approval types apply in the different countries concerned by the shipment, the UN number, proper shipping name, labelling and marking shall be in accordance with the certificate of the country of origin of design.</p> <p>Marking</p> <p>549. The <i>consignor</i> shall include in the transport documents with each <i>consignment</i> the following information, as applicable in the order given:</p> <p>(a) The proper shipping name, as specified in para 533bis;</p> <p>(b) The United Nations Class number “7”;</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>Table VIII;</p> <p>(b) The United Nations Class number “7”;</p> <p>(c) The United Nations number assigned to the material as specified in Table VIII, preceded by the letters “UN”;</p> <p>(d) The name or symbol of each radionuclide or, for mixtures of radionuclides, an appropriate general description or a list of the most restrictive nuclides;</p> <p>(e) A description of the physical and chemical form of the material, or a notation that the material is <i>special form radioactive material</i> or <i>low dispersible radioactive material</i>. A generic chemical description is acceptable for chemical form;</p> <p>(f) The maximum activity of the <i>radioactive contents</i> during transport expressed in units of becquerels (Bq) with an appropriate SI prefix (see Annex II). For <i>fissile material</i>, the mass of <i>fissile material</i> in units of grams (g), or appropriate multiples thereof, may be used in place of activity;</p> <p>(g) The category of the <i>package</i>, i.e. I-WHITE, II-YELLOW, III-YELLOW;</p> <p>(h) The <i>transport index</i> (categories II-YELLOW and III-YELLOW only);</p> <p>(i) For <i>consignments</i> including <i>fissile material</i> other than <i>consignments</i> excepted under para. 672, the <i>criticality safety index</i>;</p>	<p>(c) The United Nations number assigned to the material as specified in para 533bis, preceded by the letters “UN”;</p> <p>(d) The name or symbol of each radionuclide or, for mixtures of radionuclides, an appropriate general description or a list of the most restrictive nuclides;</p> <p>(e) A description of the physical and chemical form of the material, or a notation that the material is <i>special form radioactive material</i> or <i>low dispersible radioactive material</i>. A generic chemical description is acceptable for chemical form;</p> <p>(f) The maximum activity of the <i>radioactive contents</i> during transport expressed in units of becquerels (Bq) with an appropriate SI prefix (see Annex II). For <i>fissile material</i>, the mass of <i>fissile material</i> in units of grams (g), or appropriate multiples thereof, may be used in place of activity;</p> <p>(g) The category of the <i>package</i>, i.e. I-WHITE, II-YELLOW, III-YELLOW;</p> <p>(h) The <i>transport index</i> (categories II-YELLOW and III-YELLOW only);</p> <p>(i) For <i>consignments</i> including <i>fissile material</i> other than <i>consignments</i> excepted under para. 672, the <i>criticality safety index</i>;</p> <p>(j) The identification mark for each <i>competent authority</i> approval certificate -</p>

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSEC VIII
			<p>(j) The identification mark for each competent authority approval certificate - (special form radioactive material, low dispersible radioactive material, special arrangement, package design, or shipment) applicable to the consignment;</p> <p>(k) For consignments of more than one package, the information contained in para. 549(a) to (j) shall be given for each package. For packages in an overpack, freight container, or conveyance, a detailed statement of the contents of each package within the overpack, freight container, or conveyance and, where appropriate, of each overpack, freight container, or conveyance shall be included. If packages are to be removed from the overpack, freight container, or conveyance at a point of intermediate unloading, appropriate transport documents shall be made available;</p> <p>(l) Where a consignment is required to be shipped under exclusive use, the statement "EXCLUSIVE USE SHIPMENT"; and</p> <p>(m) For LSA-II, LSA-III, SCO-I and SCO-II, the total activity of the consignment as a multiple of A_2.</p>	<p>(k) For consignments of more than one package, the information contained in para. 549(a) to (j) shall be given for each package. For packages in an overpack, freight container, or conveyance, a detailed statement of the contents of each package within the overpack, freight container, or conveyance and, where appropriate, of each overpack, freight container, or conveyance shall be included. If packages are to be removed from the overpack, freight container, or conveyance at a point of intermediate unloading, appropriate transport documents shall be made available;</p> <p>(l) Where a consignment is required to be shipped under exclusive use, the statement "EXCLUSIVE USE SHIPMENT"; and</p> <p>(m) For LSA-II, LSA-III, SCO-I and SCO-II, the total activity of the consignment as a multiple of A_2.</p>
63	USA/02/05	508	508. The non-fixed contamination on the external surfaces of any package shall be kept as low as practicable and, under routine	508. Except as provided in para. 508bis, the non-fixed contamination on the external surfaces of any package shall be kept as low as

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Change	Proposal	Para	Existing text in TS-R-1 (2003)	Text endorsed by TRANSSC VIII
			<p>conditions of transport, shall not exceed the following limits:</p> <p>(a) 4 Bq/cm² for beta and gamma emitters and <i>low toxicity alpha emitters</i>, and</p> <p>(b) 0.4 Bq/cm² for all other alpha emitters.</p> <p>These limits are applicable when averaged over any area of 300 cm² of the surface.</p>	<p>practicable and, under routine conditions of transport, shall not exceed the following limits:</p> <p>(a) 4 Bq/cm² for beta and gamma emitters and <i>low toxicity alpha emitters</i>, and</p> <p>(b) 0.4 Bq/cm² for all other alpha emitters.</p> <p>These limits are applicable when averaged over any area of 300 cm² of any part of the surface.</p> <p>508bis The <i>non-fixed contamination</i> on the external surfaces of any <i>package</i> containing irradiated nuclear fuel that is transported under <i>exclusive use</i> shall be kept as low as practicable and, under routine conditions of transport shall not exceed 100 times the values in para. 508.</p>

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TABLE 2

CROSS REFERENCE TABLE

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Proposal	Para	Change
Canada/02/04 (1 of 2) and France/02/17	Table VIII footnote "c"	20
Canada/02/04 (2 of 2) <i>see</i> #20	Schedules	59
Canada/02/05	709	39
Canada/02/08	212	3
Canada/02/12 (1 of 6)	230	6
Canada/02/12 (2 of 6) <i>see</i> #6	230 (Canada/02/12) related change in 538	7
Canada/02/12 (3 of 6) <i>see</i> #6	230 (Canada/02/12) related change in 539	8
Canada/02/12 (4 of 6) <i>see</i> #6	805	42
Canada/02/12 (5 of 6) <i>see</i> #6	819	53
Canada/02/12 (6 of 6) <i>see</i> #6	833	56
EU/02/01 and Germany/02/01, UK/02/73	622 and consequential changes in 624, 625, 627, 628 and 646b	24
France/02/04	622 (alternate proposal A) and consequential changes in 624, 625, 627, 628 and 646b see [proposal 60 for alternate]	25
France/02/09, UK/02/61, UK/02/62, Canada/02/04, France/02/16, WNTI/02/01, WNTI/02/04 and WNTI/02/08	533, 533bis, 549	62
France/02/22	502	18
France/02/29	652 and 662	26
France/02/34	722	40
France/02/37	672	31
France/02/42	815/818	51
Germany/02/02	820	54
Germany/02/06	Table I footnote (b)	13
Japan/02/02	TABLE II (first column)	15
Sweden/02/02 (1 of 2) and France/02/06	222	4
Sweden/02/02 (2 of 2) <i>see</i> #4	222 (Sweden/02/02) related consequential changes in paras 226, 418, 543, 549, 559, 672, 831, 832, 833 and Table XII	5
Sweden/02/03	672	32
Sweden/02/07	833	57
UK/02/04	204	1
UK/02/05	204	2
UK/02/13	246	9
UK/02/14	305	11
UK/02/15	402	14
UK/02/18	Table I footnote (a)	12

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Proposal	Para	Change
UK/02/19	419	17
UK/02/22	503	19
UK/02/25	537	21
UK/02/28	566	23
UK/02/30	622 (alternate proposal B) and consequential changes in 624, 625, 627, 628 and 646	60
UK/02/35 (1 of 4) and France/02/44	672 (417bis)	27
UK/02/35 (2 of 4) <i>see</i> #27	672 (417 bis) (UK/02/35) related consequential changes in Table numbers and location	28
UK/02/35 (3 of 4) <i>see</i> #27	672 (417bis) (UK/02/35) related consequential change in para 671	29
UK/02/35 (4 of 4) <i>see</i> #27	672 (417bis) (UK/02/35) related consequential changes in paras 226, 515, TABLE VIII, 541, 549, 802, 812	30
UK/02/37 (1 of 4)	672	33
UK/02/37 (2 of 4) <i>see</i> #33	672 (UK/02/37) related change in 544	34
UK/02/37 (3 of 4) <i>see</i> #33	672 (UK/02/37) related change to TABLE X header	35
UK/02/37 (4 of 4) <i>see</i> #33	672 (UK/02/37) related consequential changes in paras 541 and 549	36
UK/02/38	814bis	47
UK/02/39 (1 of 4)	805	43
UK/02/39 (2 of 4) <i>see</i> #43	815	48
UK/02/39 (3 of 4) <i>see</i> #43	817	49
UK/02/39 (4 of 4) <i>see</i> #43	818	50
UK/02/40	805	44
UK/02/41 and UK/02/58	806	45
UK/02/43	819	52
UK/02/45	824	55
UK/02/52 and Canada/02/02, UK/02/48, UK/02/49	416	16
UK/02/52 and UK/02/58	806	46
UK/02/64	834bis	58
UK/02/66	537	22
UK/02/71	803	41
UK/02/74, UK/02/14, UK/02/60, UKRAINE/02/01 and UK/02/72	106, 107, 220bis, 301- 315 (partly paragraph reordering), 562	61
USA/02/01	677	38
USA/02/02	672	37
USA/02/05	508	63
USA/02/07	303	10

PROPOSED CHANGES FOR 120 DAY REVIEW

APPENDIX 1

CHANGE #5 (SWEDEN/02/02, 2 of 2)

**CONSEQUENTIAL CHANGES
IF CHANGE #4 (SWEDEN/02/02, 1 of 2) WERE ACCEPTED**

PROPOSED CHANGES FOR 120 DAY REVIEW

Sweden/02/02 – Additional consequential changes due to accepted proposal

Current texts often correspond more to the proposed definition than to the current one. Many of the texts that are changed are identical but refer to different paragraphs or schedules. Both “fissile materials” and “fissile nuclides” are important terms that should be maintained.

Regulations					
Section, Para. or location (number of occurrences)	Current use of “fissile”		Proposed use of “fissile” (bold type indicates change)		Comment Change without text proposal means “material” is exchanged for “nuclide(s)”
	Material	Nuclide(s)	Material	Nuclide(s)	
Section II					
222. Definition text	Yes	No	Yes	Yes	Major change
226(a)(iii) LSA-I def. ”excluding FM in quantities not excepted...”	Yes	No	No	Yes	Changed. “excluding FN quantities not excepted ...”
226(a)(iv) LSA-I def. ”excluding FM in quantities not excepted...”	Yes	No	No	Yes	Changed. “excluding FN quantities not excepted ...”
Section IV					
418. Contents (3)	Yes	No	Yes	Yes	Change “(a) quantities of FNs not authorized ...” “(b) any radionuclide different from ...”
Section V					
543(b) Activity (2)	Yes	No	Yes	Yes	Change “For FM, the mass of fissile nuclides ...”
549(f) (2)	Yes	No	Yes	Yes	Change “For FM, the mass of fissile nuclides ...”
559(e) Notification (2)	Yes	No	Yes	Yes	Change “For FM, the mass of fissile nuclides ...”
Section VI					
672(a) Formula	Yes	No	No	Yes	Change
672(a)(i) 15 g	Yes	No	No	Yes	Change
672(a)(iii) 5 g/10 l	Yes	No	No	Yes	Change
672(b) 1% enrichm.	Yes	No	No	Yes	Change
Table XII body (3)	Yes	No	No	Yes	Change
Section VIII					
831(j) Special arr. App. cert. Contents	Yes	No	No	Yes	Change
832(j) Shipm. Appr.	Yes	No	No	Yes	Change
833(l) Package design, Contents	Yes	No	No	Yes	Change

PROPOSED CHANGES FOR 120 DAY REVIEW

Schedules					
Section, Para. or location (number of occurrences)	Current use of “fissile”		Proposed use of “fissile” (bold type indicates change)		Comment Change without text proposal means “material” is exchanged for “nuclide(s)”
	Material	Nuclide(s)	Material	Nuclide(s)	
Schedule 5. 1.(b)(iii)	Yes	No	No	Yes	Changed. “excluding FN quantities not excepted ...”
Schedule 5. 1.(b)(iv)	Yes	No	No	Yes	Changed. “excluding FN quantities not excepted ...”
Schedule 6. 2.(f)	Yes	No	No	Yes	Changed. “excluding FN quantities not excepted ...”
Schedule 6. 2.(g)	Yes	No	No	Yes	Changed. “excluding FN quantities not excepted ...”
Schedule 7. 2.(f)	Yes	No	No	Yes	Changed. “excluding FN quantities not excepted ...”
Schedule 7. 2.(g)	Yes	No	No	Yes	Changed. “excluding FN quantities not excepted ...”
Schedule 8.2.(d)	Yes	No	No	Yes	Changed. “excluding FN quantities not excepted ...”
Schedule 9. 2.(e)	Yes	No	No	Yes	Changed. “excluding FN quantities not excepted ...”
Schedule 9. 2.(f)	Yes	No	No	Yes	Changed. “excluding FN quantities not excepted ...”
Schedule 13. 1. Def. (2)	Yes	No	Yes	Yes	Major change See 222.

PROPOSED CHANGES FOR 120 DAY REVIEW

ADVISORY MATERIAL					
Section, Para. or location	Current use of "fissile"		Proposed use of "fissile" (bold type indicates change)		Comment Change without text proposal means "material" is exchanged for "nuclide(s)"
	Material	Nuclide(s)	Material	Nuclide(s)	
222.1	Yes	No	Yes	No	Delete two last sentences: "In the Regulations the term 'fissile material' is occasionally used to refer both to fissile radionuclides and to material containing those radionuclides. Users of the Regulations should remain alert to the context in which the term 'fissile material' is used.
222.3	Yes	No	Yes	No	Modify to: "As indicated in the above paragraph, the basis used to select the fissile nuclides in the definition of fissile material for the purposes of the Regulations relies on ..."
Advisory text appears to be written with fissile material as a general term that can be used with either definition (specific nuclides or material including such nuclides). Further changes are not necessary					

APPENDIX 2

CONSOLIDATED VERSION OF PROPOSED CHANGES

#27 UK/02/35 (1 of 4),

#31 France/02/37,

#32 Sweden/02/03 and

#33 UK/02/37 (1 of 4)

CONCERNING PARAGRAPH 672

CURRENT TEXT IN TS-R-1 PARA 672

672. *Fissile material* meeting one of the provisions (a)–(d) of this paragraph is exempted from the requirement to be transported in packages that comply with paras 673–682 as well as the other requirements of these Regulations that apply to *fissile material*. Only one type of exception is allowed per *consignment*.

(a) A mass limit per *consignment* such that:

$$\frac{\text{mass of uranium-235 (g)} + \text{mass of other fissile material (g)}}{X + Y} < 1$$

where X and Y are the mass limits defined in Table XII, provided that either:

- (i) each individual *package* contains not more than 15 g of *fissile material*; for unpackaged material, this quantity limitation shall apply to the *consignment* being carried in or on the *conveyance*, or
- (ii) the *fissile material* is a homogeneous hydrogenous solution or mixture where the ratio of fissile nuclides to hydrogen is less than 5% by mass, or
- (iii) there is not more than 5 g of *fissile material* in any 10 litre volume of material.

Neither beryllium nor deuterium in hydrogenous material enriched in deuterium shall be present in quantities exceeding 1% of the applicable *consignment* mass limits provided in Table XII.

- (b) Uranium enriched in uranium-235 to a maximum of 1% by mass, and with a total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that the *fissile material* is distributed essentially homogeneously throughout the material. In addition, if uranium-235 is present in metallic, oxide or carbide forms, it shall not form a lattice arrangement.
- (c) Liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by mass, with a total plutonium and uranium-233 content not exceeding 0.002% of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2.
- (d) Packages containing, individually, a total plutonium mass not more than 1 kg, of which not more than 20% by mass may consist of plutonium-239, plutonium-241 or any combination of those radionuclides.

<p>PROPOSED TEXT TO REPLACE 672, COMBINING PROPOSED CHANGES #27, #31, #32 AND #33</p>	<p>417bis. Packages containing fissile material, other than packages approved for the carriage of fissile material, and provided that the smallest external dimension of each package is not less than 10 cm, shall meet one of the exceptions (a)–(d). Only one type of exception is allowed per consignment.</p> <p>(a) A mass limit per consignment such that:</p> $CSI = \frac{\text{mass of uranium-235 (g)}}{X} + \frac{\text{mass of other fissile material (g)}}{Y} * 50$ <p>where X and Y are the mass limits defined in Table IV, provided that either:</p> <ul style="list-style-type: none"> (i) each individual package contains not more than 15 g of <i>fissile material</i>; for unpackaged material, this quantity limitation shall apply to the <i>consignment</i> being carried in or on the <i>conveyance</i>, or (ii) the <i>fissile material</i> is a homogeneous hydrogenous solution or mixture where the ratio of fissile nuclides to hydrogen is less than 5% by mass, or (iii) there is not more than 5 g of <i>fissile material</i> in any 10 litre volume of material. <p>Neither beryllium nor deuterium shall be present in quantities exceeding 1% of the applicable consignment mass limits provided in Table IV, except for deuterium in natural concentration in hydrogen.</p> <ul style="list-style-type: none"> (b) Uranium enriched in uranium-235 to a maximum of 1% by mass, and with a total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that the <i>fissile material</i> is distributed essentially homogeneously throughout the material. In addition, if uranium-235 is present in metallic, oxide or carbide forms, it shall not form a lattice arrangement. (c) Liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by mass, with a total plutonium and uranium-233 content not exceeding 0.002% of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2. (d) Packages containing, individually, a total plutonium mass not more than 1 kg, of which not more than 20% by mass may consist of plutonium-239, plutonium-241 or any combination of those radionuclides.
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PROPOSED CHANGES FOR 120 DAY REVIEW

APPENDIX 3

CHANGE #51

**TRANSITIONAL ARRANGEMENTS
(PARAGRAPHS 815/818)**

PROPOSED CHANGES FOR 120 DAY REVIEW

FRANCE/02/42 TRANSITIONAL ARRANGEMENTS (Paras 815/818)

CURRENT TEXT IN TS-R-1

TRANSITIONAL ARRANGEMENTS

Packages not requiring competent authority approval of design under the 1985 and 1985 (As Amended 1990) Editions of these Regulations

815. *Excepted packages, Type IP-1, Type IP-2 and Type IP-3 and Type A packages* that did not require *approval of design* by the *competent authority* and which meet the requirements of the 1985 or 1985 (As Amended 1990) Editions of these Regulations may continue to be used subject to the mandatory programme of *quality assurance* in accordance with the requirements of para. 310 and the activity limits and material restrictions of Section IV. Any *packaging* modified, unless to improve safety, or manufactured after 31 December 2003, shall meet this Edition of the Regulations in full. *Packages* prepared for transport not later than 31 December 2003 under the 1985 or 1985 (As Amended 1990) Editions of these Regulations may continue in transport. *Packages* prepared for transport after this date shall meet this Edition of the Regulations in full.

Packages approved under the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) Editions of these Regulations

816. *Packagings* manufactured to a *package design* approved by the *competent authority* under the provisions of the 1973 or 1973 (As Amended) Editions of these Regulations may continue to be used, subject to: *multilateral approval of package design*, the mandatory programme of *quality assurance* in accordance with the applicable requirements of para. 310; the activity limits and material restrictions of Section IV; and, for a *package* containing *fissile material* and transported by air, the requirement of para. 680. No new manufacture of such *packaging* shall be permitted to commence. Changes in the *design* of the *packaging* or in the nature or quantity of the authorized *radioactive contents* which, as determined by the *competent authority*, would significantly affect safety shall require that this Edition of the Regulations be met in full. A serial number according to the provision of para. 538 shall be assigned to and marked on the outside of each *packaging*.

817. *Packagings* manufactured to a *package design* approved by the *competent authority* under the provisions of the 1985 or 1985 (As Amended 1990) Editions of these Regulations may continue to be used until 31 December 2003, subject to: the mandatory programme of *quality assurance* in accordance with the requirements of para. 310; the activity limits and material restrictions of Section IV; and, for a *package* containing *fissile material* and transported by air, the requirement of para. 680. After this date use may continue subject, additionally, to *multilateral approval of package design*. Changes in the *design* of the *packaging* or in the nature or quantity of the authorized *radioactive contents* which, as determined by the *competent authority*, would significantly affect safety shall require that this Edition of the Regulations be met in full. All *packagings* for which manufacture begins after 31 December 2006 shall meet this Edition of the Regulations in full.

Special form radioactive material approved under the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) Editions of these Regulations

PROPOSED CHANGES FOR 120 DAY REVIEW

818. *Special form radioactive material* manufactured to a *design* which had received *unilateral approval* by the *competent authority* under the 1973, 1973 (As Amended), 1985 or 1985 (As Amended 1990) Editions of these Regulations may continue to be used when in compliance with the mandatory programme of *quality assurance* in accordance with the applicable requirements of para. 310. All *special form radioactive material* manufactured after 31 December 2003 shall meet this Edition of the Regulations in full.

PROPOSED CHANGES FOR 120 DAY REVIEW

PROPOSED TEXT IN FRANCE/02/42

Paragraphs affected and proposed text change to regulatory text in TS-R-1 (ST-1, Rev.)

TRANSITIONAL ARRANGEMENTS

Packages not requiring competent authority approval of design under the 1985, 1985 (As Amended 1990) and 1996 (Revised and Amended 2005) Editions of these Regulations

815. Excepted packages, Industrial packages Types IP-1, IP-2 and IP-3 and Type A packages which did not require approval of design by the competent authority and which meet the requirements of an Edition of the Regulations specified in column 1 of Table XIV may continue to be prepared, or such packagings may continue to be manufactured, until the corresponding date specified in column 3 of Table XIV. Packages prepared for transport not later than the date specified in column 3 of Table XIV for the corresponding Edition of the Regulations specified in column 1, may continue in transport until the corresponding date specified in column 4 of Table XIV. Except as allowed in this paragraph, manufacture of packagings and use of packages shall be subject to the mandatory programme of quality assurance in accordance with the requirements of para 310; and the activity limits and material restrictions of Section IV , the requirements and controls for transport of section V; for a package containing fissile material, the requirements of para. 672 and for a package containing fissile material transported by air, the requirements of para. 680.

815bis.Excepted packages, Industrial packages Types IP-1, IP-2 and IP-3 and Type A packages which did not require approval of design by the competent authority may be modified or continued to be designed until the date specified in column 2 of Table XIV in accordance with the requirements of the corresponding Edition of the Regulations specified in column 1 of Table XIV. Except as allowed in this paragraph, modification of packaging and design of packages shall be subject to the mandatory programme of quality assurance in accordance with the requirements of para. 310; and the activity limits and material restrictions of Section IV , the requirements and controls for transport of section V; for a package containing fissile material, the requirements of para. 672 and for a package containing fissile material transported by air, the requirements of para. 680.

Table XIV : PACKAGES NOT REQUIRING COMPETENT AUTHORITY APPROVAL OF DESIGN

Edition of the regulation*	Design or modification until	Manufacture and prepare until	End of transport
1985	Dec. 31, 2003 ⁺	Dec. 31, 2003 ⁺	2028
1996	Dec. 31, 2006	Dec. 31, 2010	2034

* Includes Revised Editions and Amended Editions

⁺ dates which are already mandatory according to edition that have been in force (para 815 of the 1996 edition)

PROPOSED CHANGES FOR 120 DAY REVIEW

Packages approved under the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) and 1996 (Revised and Amended 2005) Editions of these Regulations

816. Packagings manufactured to a package design approved by the competent authority as meeting the Edition of the Regulations specified in column 1 of Table XV may continue to be used until the date specified in column 4 of Table XV corresponding with the Edition of the Regulations specified in column 1 of Table XV. After this date use may continue, until the corresponding date specified in column 6 of Table XV, subject, additionally, to multilateral approval of package design. A serial number according to the provision of para. 538 shall be assigned to and marked on the outside of each packaging. Except as allowed in this paragraph, use of packagings shall be subject to the mandatory programme of quality assurance in accordance with the requirements of para. 310; and the activity limits and material restrictions of Section IV, the requirements and controls for transport of section V; for a package containing fissile material, the requirements of para. 672 and for a package containing fissile material transported by air, the requirements of para. 680.

816bis. Packagings, for which the package design was approved by a competent authority, may be manufactured until the date specified in column 5 of Table XV corresponding to the Edition of the Regulations in column 1 of Table XV to which the package design was approved. After this date no new manufacture shall commence. Except as allowed in this paragraph, manufacture of packagings shall be subject to the mandatory programme of quality assurance in accordance with the requirements of para. 310; and the activity limits and material restrictions of Section IV, the requirements and controls for transport of section V; for a package containing fissile material, the requirements of para. 672 and for a package containing fissile material transported by air, the requirements of para. 680.

816bis+1. Packages which require competent authority approval of design may continue to be designed until the date specified in column 3 of Table XV, in accordance with the requirements of the corresponding Edition of the Regulations specified in column 1 of Table XV. The commencing of any new design or modification in design which, as determined by the competent authority, would significantly affect safety, shall require the package design to meet this edition of the Regulations in full. Changes in the design or in the nature or quantity of the authorized radioactive contents which, as determined by the competent authority, would not significantly affect safety, may be made after the date specified in column 3 of Table XV manufactured to a design which had received unilateral approval by the competent authority under an Edition of the Regulations specified in column 1 of Table XV may continue to be used until the corresponding date specified in column 6 of Table XV. Except as allowed in this paragraph, design and modification of packages shall be subject to the mandatory programme of quality assurance in accordance with the requirements of para. 310; and the activity limits and material restrictions of Section IV, the requirements and controls for transport of section V; for a package containing fissile material, the requirements of para. 672 and for a package containing fissile material transported by air, the requirements of para. 680.

Special form radioactive material, in accordance with the requirements of the corresponding Edition of the Regulations specified in column 1 of Table XV **approved under the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) and 1996 (Revised and As amended 2005) Editions of these Regulations and low dispersible material**

PROPOSED CHANGES FOR 120 DAY REVIEW

818. Special form radioactive material . Except as allowed in this paragraph, use of special form material shall be subject to the mandatory programme of quality assurance in accordance with the requirements of para. 310.

818bis. Special form radioactive material may continue to be designed or modified until the date specified in column 3 of Table XV in accordance with the requirements of the corresponding Edition of the Regulations specified in column 1 of Table XV. Changes in the design which, as determined by the competent authority, would not significantly affect safety, may be made after the date specified in column 3 of Table XV, in accordance with the requirements of the corresponding Edition of the Regulations specified in column 1 of Table XV. Except as allowed in this paragraph, design and modification of special form material shall be subject to the mandatory programme of quality assurance in accordance with the requirements of para. 310.

818bis+1. Special form radioactive material may be manufactured until the date specified in column 5 of Table XV corresponding to the Edition of the Regulations in column 1 of Table XV to which the design is approved. After this date no new manufacture shall commence. Except as allowed in this paragraph, manufacture of special form material shall be subject to the mandatory programme of quality assurance in accordance with the requirements of para. 310.

Low dispersible radioactive material approved under a previous Edition of these Regulations

818bis+2. Low dispersible radioactive material manufactured to a design which had received multilateral approval by the competent authority under the Edition of the Regulations specified in column 1 of Table XV may continue to be used until the corresponding date specified in column 6 of Table XV. Except as allowed in this paragraph, use of low dispersible radioactive material shall be subject to the mandatory programme of quality assurance in accordance with the requirements of para. 310.

818bis+3. Low dispersible radioactive material may be designed or modified until the date specified in column 3 of Table XV in accordance with the requirements of the corresponding Edition of the Regulations specified in column 1 of Table XV. Changes in the design which, as determined by the competent authority, would not significantly affect safety, may be made after the date specified in column 3 of Table XV, in accordance with the requirements of the corresponding Edition of the Regulations specified in column 1 of Table XV. Except as allowed in this paragraph, design and modification of low dispersible radioactive material shall be subject to the mandatory programme of quality assurance in accordance with the requirements of para. 310.

819 reference to 816-817 becomes reference to 816

Amend para 828(d) as follows:

REPLACE ALL OCCURRENCES OF "96" BY "05".

Amend para 829 as follows:

REPLACE ALL OCCURRENCES OF "96" BY "05".

PROPOSED CHANGES FOR 120 DAY REVIEW

Table XV: COMPETENT AUTHORITY APPROVED PACKAGES AND MATERIALS

Edition of the regulations *	Type	Design or Modification until	Multilateral approval after	Commence manufacture until	End of use
1967	All Packages				Dec. 31, 2001
	Special Form				Dec. 31, 2001
1973	All Packages	Dec. 31,1995 ⁺	Dec. 31,1992 ⁺	Dec. 31, 1995 ⁺	Dec. 31, 2019
	Special Form	Dec. 31,1995 ⁺	N/A	Dec. 31, 2003 ⁺⁺	Dec. 31, 2019
1985	All Packages	Dec. 31,2001 ^{**}	Dec. 31,2003 ^{**}	Dec. 31, 2006 ^{**}	Dec. 31, 2028
	Special Form	Dec. 31,2001 ^{**}	N/A	Dec. 31,2003 ⁺⁺	Dec. 31, 2028
1996	All Packages	Dec. 31,2012	Dec. 31,2016	Dec. 31, 2018	Dec. 31, 2034
	Special Form	Dec. 31,2008	N/A	Dec. 31,2012	Dec. 31, 2034
	Low Dispersible	Dec. 31,2008	N/A	Dec. 31,2012	Dec. 31, 2034

* Includes Revised Editions and Amended Editions

Nota: dates which are already mandatory according to edition that have been in force:

⁺para 714 of the 1985 edition

^{**}para 817 of the 1996 edition

⁺⁺para 818 of the 1996 edition

RELATED PROPOSED TEXT FOR TS-G-1.1

Paragraphs affected and proposed text change to advisory material in TS-G-1.1

538.3bis In the case where package designs are updated to meet newer standards it may be appropriate to apply the date suffix to the competent authority identification mark as a legible and durable label. This is particularly justified when some of the packagings of the same initial design have not yet been or cannot be modified to the updated design.

TRANSITIONAL ARRANGEMENTS

Packages not requiring competent authority approval of design under previous editions of these Regulations

815.1. Following from the adoption of the 1985 Editions of the Regulations, packages not requiring approval of design by competent authority based on the 1973 Edition of the Regulations and the 1973 (As Amended) Edition of the Regulations could no longer be used. Continued operational use of such packages required either that the design be reviewed according to the requirements of the 1985 Editions of the Regulations, or that shipments reviewed and approved by the competent authority as special arrangements, although this was not explicitly stated in the Regulations.

815.2. Paragraph 815 was introduced into the 1996 Edition of the Regulations to allow such existing packagings to continue in use for a limited and defined period of time, following

PROPOSED CHANGES FOR 120 DAY REVIEW

publication, during which the designs might be reviewed, and if necessary modified, to ensure they meet the requirements of the current Edition of the Regulations in full. Where such review and/or modification proves impractical, the transition period is intended to allow time for package designs to be phased out and new designs meeting the requirements of the latest Edition of the Regulations to be phased in.

815.3 Such transitional arrangements for packages not requiring competent authority approval were continued in the 2005 Edition of the Regulations, using time intervals based on a broad consensus view on the intervals necessary. The dates were introduced into a table format (Table XIV) to facilitate updating the transitional arrangements for these packages during future revisions of the regulations.

815.4 Packages prepared in accordance with previous Editions of the Regulations are sometimes stored for many years prior to further shipment. This may be particularly applicable in the case of Industrial or Type A packages containing radioactive waste and awaiting shipment to intermediate or final storage repositories. Paragraph 815 allows such packages, prepared during a defined period of time and when properly maintained, to be transported in the future on the basis of compliance with the earlier Editions of the Regulations.

815.5. Paragraph 815 emphasizes the requirement to apply quality assurance measures, according to the latest Edition of the Regulations, to ensure that only such packages remain in use, where they continue to meet the original design intent or regulatory requirements. This can best be achieved by ensuring that the latest quality assurance measures are applied to post-manufacturing activities such as servicing, maintenance, modification and use of such packages.

815.6. The reference to Section IV of the current Regulations is included to ensure that only the most recent radiological data (as reflected in A1 and A2 values) are used to determine package content and other related limits. It should be noted that the scope of the transitional arrangements of the regulations only extends to the requirements for certain packagings and packages. In all other aspects e.g., concerning general provisions; the requirements and controls for transport including consignment and conveyance limits; and approval and administrative requirements, the provisions of the Edition of the Regulations in force apply.

815.7. With the introduction of a new Edition of the Regulations that could be published in 2007, packages that do not require competent authority approval of the design that meet the 2005 Edition of the regulations would similarly be grandparented. The proposed grandparenting periods could be consistent with those intervals established in the 1996 Edition of the Regulations. The end-of-design or-modification date would be December 31, 2008, the end-of-manufacture date would be December 2012 and the end-of- use date would be December 31 2036, assuming publication of the next Edition in 2007 with an implementation date after December 31, 2008. These dates may be modified considering the extent of the changes in the package design standards in the new Regulations.

815bis.1. Any revision to the original package design, or increase in contained activity, or addition of other types of radioactive materials, which would significantly and detrimentally affect safety, as determined by the package owner in consultation with the package designer, will require the design to be reassessed according to the latest Edition of the Regulations. This could include such things as an increase in the mass of the contents, changes to the closure, changes to any impact limiters, changes to the thermal protection and shielding and changes in the form of

PROPOSED CHANGES FOR 120 DAY REVIEW

the contents. Paragraph 815 bis defines the time period during which design and modifications may be made to a package design following the publication of revised Regulations. This paragraph refers to Table XIV which lists the date applicable to designs that meet the specified Editions of the Regulations. By default, modifications to improve safety are allowed until the date in column 3 of Table XIV (end of manufacture and use date).

815bis.2. The most recent radiological data, as reflected in the A1 and A2 values are used to determine package content and other related limits - this concerns the limitations given in paras. 226, 408, 410 to 414, 525, 601. The most recent data relative to fissile exceptions also need to be used.

Packages approved under previous Editions of these Regulations

816.1. Previous Editions of the Regulations have included provisions that allow packages requiring approval of design by competent authority (Type B, Type B(U), Type B(M), Type C packages, packages for uranium hexafluoride and package designs for fissile material) based on earlier Editions of the Regulations to be continued in use, subject to certain limitations on new manufacture, additional requirements to mark such packages with serial numbers and multilateral approval of all such designs. This provision, known colloquially as 'grandparenting', was newly introduced into the 1985 Editions of the Regulations to ease the transition to those Regulations. This allowed packages, provided they were properly maintained and continued to meet their original design intent, to continue in use to the end of their useful design lives. It also provided for a period of time, following publication, during which the designs could be reviewed, and, if necessary, modified, to ensure packages met the requirements of the 1985 Edition of the Regulations in full. Where such review and/or modification proved impractical, the transition period allowed time for packages to be phased out and new designs meeting the requirements of the 1985 Edition of the Regulations to be phased in.

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816.2. Such transitional arrangements for packages were continued in the 2005 Edition of the Regulations, using time intervals consistent with those in the 1996 Edition. The dates specified in the grandparenting provisions have been included in the Regulations in a tabular format (Table XV).

816.3 When applying para 816, the original competent authority identification mark and design codes, assigned by the competent authority of design, should be retained both on the packages and on the competent authority certificates of design approval, notwithstanding that these packages may become subject to multilateral approval of design. This means that packages originally designated Type B(U)-85 or Type B(U)F-85 under the 1985 Editions of the Regulations should not be redesignated Type B(M)-85 or Type B(M)F-85, nor should they be redesignated Type B(M)-05 or Type B(M)F-05, when used under the provisions of para. 816. This is to ensure that such packages can be clearly identified as packages "grandfathered" under the provisions of paragraph 816, having been originally approved under the 1985 Editions of the Regulations.

816.4. The most recent radiological data, as reflected in the A1 and A2 values are used to determine package content and other related limits - this concerns the limitations given in paras. 416, 558, 657, 730, 820. It is also noted that when the A1 or A2 value is listed as a limit in the package approval (for example, contents may be limited to a certain number of A2's instead of specific radionuclides), the new A1 and A2 values in the new regulations should be used, without a transitional period. It is not expected that the calculations that may have been used to demonstrate compliance with the release criteria in paras. 656 and 669 of these Regulations will be immediately updated to include the most recent A2 values. If the package is evaluated to a more recent edition of the Regulations, the analysis, including the A2 values, should be updated.

816.5. The reference to Section IV and para. 680 of the Edition of the Regulations in force is included to ensure that only the most recent radiological data (as reflected in the A1 and A2 values), and requirements for fissile material by air, may be used to determine package content and other related limits. It should be noted that the scope of the transitional arrangements of the regulations only extends to the requirements for certain packagings and packages. In all other aspects e.g., concerning general provisions, the requirements and controls for transport including consignment and conveyance limits, and approval and administrative requirements, the provisions of the Edition of the Regulations in force apply.

816.6. In the process of developing the 1996 Edition of the Regulations it was determined that there was no need for an immediate change of package designs following the adoption of the Regulations, but that changes aiming at a long term improvement of safety in transport were justified. Therefore it was also decided to accept continued operational use of certain packages designed and approved under the 1973 Editions of the Regulations. The continued use of existing packagings with a 1967 Edition based package design approval was considered to be no longer necessary or justified and was not authorized in the 1985 Edition and subsequent Editions of the Regulations.

816.7. The continued use of packages approved under previous Editions of the Regulations is subject to multilateral approval from the date in column 4 of Table XV, in order to permit the competent authorities to establish a framework within which continued use may be approved.

816.8. The grandparenting provisions collectively allow transport of packages and materials for which the designs were approved to a previous Edition of the Regulations. Transport of

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grandparented designs will comply with other applicable requirements of the Edition of Regulations in force at the time of transport. The various grandparenting provisions specifically call out provisions in the Edition of the Regulations in force at the time of transport, such as quality assurance requirements of para. 310, the activity limits and materials restrictions of Section IV, and the requirements of para. 680 for packages containing fissile material and transported by air. Other provisions of the Edition of the Regulations in force at the time of transport must also be applied, such as the applicable general provisions in Section III, requirements and controls for transport in Section V, and approval and administrative requirements of Section VIII

816.9. With the excepted publication in 2007 of a new Edition of the Regulations and its implementation after December 31, 2008, competent authority approved packages that meet the 2005 Edition of the Regulations would similarly be grandparented. The proposed grandparenting periods of Table XV could be consistent with those intervals established in the 1985 and 1996 Editions of the Regulations. For packages, the end-of-design or-modification date would be December 31, 2014, the commence-manufacture until date would be December 31, 2020, the use-under-multilateral approval would be until December 31, 2036. These dates may be modified considering the extent of the changes in the package design standards in the future edition of the Regulations.

816bis.1. See para. 538.2.

816bis.2 Specified time intervals are also given for continued fabrication of designs that were approved to previous Editions of the Regulations. After such a period, fabrication is not permitted to commence.

816bis+1.1 To accommodate possible frequent revision of the package design standards in the Regulations, a new transitional period for design and modification is defined. This period allows the design and certification of the package to be performed under a single Revision of the Regulations. It is appropriate to consider the date of application to the competent authority as the relevant date. During this period of changes in the design of the packages or in the nature or quantity of the radioactive contents which would significantly and detrimentally affect safety, as determined by the competent authority, would be assessed under the design standards in effect at the time of the design approval. This could include an increase in the mass of the contents, changes to the closure, changes to any impact limiters, changes to the thermal protection or shielding and changes in the form of the contents. For a two-year revision cycle, it is judged that the period of time needed for package design, testing, approval by the competent authority, and fabrication may last over several revisions of the regulations. Modifications to the package design are commonly needed to allow the transport of new contents, or to include design improvements, particularly those based on operational experience. The specified design interval has been established to allow these activities to be performed under a single set of regulatory requirements.

816bis+1.2 The most recent radiological data, as reflected in the A1 and A2 values are used to determine package content and other related limits - this concerns the limitations given in paras. 416, 558, 657, 730, 820. It is also noted that when the A1 or A2 value is listed as a limit in the package approval (for example, contents may be limited to a certain number of A2's instead of specific radionuclides), the new A1 and A2 values in the new regulations should be used, without a transitional period. It is not expected that the calculations that may have been used to demonstrate compliance with the release criteria in paras. 656 and 669 of these Regulations will be immediately updated to include the most recent A2 values. If the package is evaluated to a

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more recent edition of the Regulations, the analysis, including the A2 values, should be updated. Special form radioactive material approved under previous Editions of these Regulations

818.1. Paragraph 818 introduces transitional arrangements for special form radioactive material, the design of which is also subject to competent authority approval. It specifies the need to apply quality assurance measures according to the Edition of the Regulations in force to ensure that such special form radioactive material remains in use, only where it continues to meet the original design intent or regulatory requirements. This can best be achieved by ensuring that the latest quality assurance measures are applied to post-manufacturing activities such as servicing, maintenance, modification and use of such special form material. It should be noted that the scope of the transitional arrangements of the regulations only extends to the requirements for certain special form radioactive materials. In all other aspects e.g., concerning general provisions; the requirements and controls for transport including consignment and conveyance limits; and approval and administrative requirements, the provisions of the Edition of the Regulations in force apply.

818.2. In the process of developing the 1996 Edition of the Regulations it was determined that there was no need for an immediate change in the design of special form radioactive material following the adoption of the Regulations, but that changes aiming at a long term improvement of safety in transport were justified. Therefore it was also decided to accept continued operational use of special form radioactive material designed and approved under the 1973 or 1985 Editions of the Regulations. However, no new manufacture of such special form radioactive material is permitted to commence beyond 31 December 2003 as specified in the 1996 edition. The continued use of existing special form radioactive material with a 1967 Edition based design approval was considered to be no longer necessary or justified.

818.3. With the excepted publication in 2007 of a new Edition of the Regulations and its implementation after December 31, 2008, competent authority approved designs for special form radioactive material and low dispersible material that meet the 2005 Edition of the Regulations would similarly be grandparented. The proposed grandparenting periods could be consistent with those intervals established in the 1996 Editions of the Regulations. For these materials the end-of-design-or modification date would be December 31, 2010, and the commence-manufacture-until date would be December 31, 2014. The use would be until December 31, 2036. These dates may be modified considering the extent of the changes in the design standards in the new Regulations.

828.2. It is essential that easy means are available for determining under which edition of the Regulations the original package design approval was issued, preferably in the identification mark. This will be achieved by adding the symbol '-05' to the type code. Using this two-digit year designation should be continued through subsequent revisions of the regulations.

Example:

Edition of Regulations	Package design identification mark
1967 Edition	A/132/B
1973 Edition	A/132B(U), or A/132/B(M)
1985 Edition	A/132/B(U)-85, or A/132/B(M)-85
1996 Edition	A/132/B(U)-96, or A/132/B(M)-96
2005 Edition	A/132/B(U)-05, or A/132/B(M)-05

APPENDIX 4

CHANGE #61

**RADIATION PROTECTION
(PARAGRAPHS 106, 107, 220bis, 301- 315 (partly paragraph reordering), 562)**

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<p>106. These Regulations apply to the transport of <i>radioactive material</i> by all modes on land, water or in the air, including transport which is incidental to the use of the <i>radioactive material</i>. Transport comprises all operations and conditions associated with and involved in the movement of <i>radioactive material</i>; these include the design, manufacture, maintenance and repair of <i>packaging</i>, and the preparation, consigning, loading, carriage including in-transit storage, unloading and receipt at the final destination of loads of <i>radioactive material</i> and <i>packages</i>. A graded approach is applied to the performance standards in these Regulations that is characterized by three general severity levels:</p> <ul style="list-style-type: none"> (a) routine conditions of transport (incident free); (b) normal conditions of transport (minor mishaps); (c) accident conditions of transport. 	<p>106. These Regulations apply to the transport of <i>radioactive material</i> (as defined in para 236) by all modes on land, water or in the air, including transport which is incidental to the use of the <i>radioactive material</i>. Transport comprises all operations and conditions associated with and involved in the movement of <i>radioactive material</i>; these include the design, manufacture, maintenance and repair of <i>packaging</i>, and the preparation, consigning, loading, carriage including in-transit storage, unloading and receipt at the final destination of loads of <i>radioactive material</i> and <i>packages</i>. A graded approach is applied to the performance standards in these Regulations that is characterized by three general severity levels:</p> <ul style="list-style-type: none"> (a) routine conditions of transport (incident free); (b) normal conditions of transport (minor mishaps); (c) accident conditions of transport. 	<p>Inclusion of specific reference to definition of radioactive material on advice from G. Dicke as italics is not always carried into modal regulations.</p>
<p>107. The Regulations do not apply to:</p>	<p>107. The Regulations do not apply to sources of exposure, or practices, which are either excluded from these regulations or exempted from the requirements of these regulations according to the principles of the “International Basic Safety Standards for Protection Against Ionizing Radiation and the Safety of Radiation Sources” IAEA Safety Series No. 115 [2], and in particular the following are not within the scope of these Regulations:</p>	<p>Reference to generic exclusion and exemption from BSS, but retaining existing specific exclusions/exemptions. Advisory expanded to include explanation of exclusion and to advise on need for regular review.</p>

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<p>(a) radioactive material that is an integral part of the means of transport;</p> <p>(b) radioactive material moved within an establishment which is subject to appropriate safety regulations in force in the establishment and where the movement does not involve public roads or railways;</p> <p>(c) radioactive material implanted or incorporated into a person or live animal for diagnosis or treatment;</p> <p>(d) radioactive material in consumer products which have received regulatory approval, following their sale to the end user;</p> <p>(e) natural material and ores containing naturally-occurring radionuclides which are either in their natural state, or have only been processed for purposes other than for extraction of the radionuclides, and which are not intended to be processed for use of these radionuclides, provided the activity concentration of the material does not exceed 10 times the values - specified in paras 401–406;</p> <p>(f) non-radioactive solid objects with radioactive substances present on any surfaces in quantities not in excess of the limit defined in para. 214*.</p>	<p>(a) radioactive material that is an integral part of the means of transport;</p> <p>(b) radioactive material moved within an establishment which is subject to appropriate safety regulations in force in the establishment and where the movement does not involve public roads or railways;</p> <p>(c) radioactive material implanted or incorporated into a person or live animal for diagnosis or treatment;</p> <p>(d) radioactive material in consumer products which have received regulatory approval, following their sale to the end user;</p> <p>(e) natural material and ores containing naturally-occurring radionuclides which are either in their natural state, or have only been processed for purposes other than for extraction of the radionuclides, and which are not intended to be processed for use of these radionuclides, provided the activity concentration of the material does not exceed 10 times the values - specified in paras 401–406;</p> <p>(f) non-radioactive solid objects with radioactive substances present on any surfaces in quantities not in excess of the limit defined in para. 214.</p>
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<p>No current Text</p>	<p><u>Dose constraint</u></p> <p>220 bis <i>Dose constraint</i> shall mean a prospective and source related restriction on the individual dose delivered by the source which serves as a bound in the optimization of protection and safety of the source. For occupational exposures, dose constraint is a source related value of individual dose used to limit the range of options considered in the process of optimization. For public exposure, the dose constraint is an upper bound on the annual doses that members of the public should receive from the planned operation of any controlled source. The exposure to which the dose constraint applies is the annual dose to any critical group, summed over all exposure pathways, arising from the predicted operation of the controlled source. The dose constraint for each source is intended to ensure that the sum of doses to the critical group from all controlled sources remains within the dose limit.</p>	<p>Definition of dose constraint added (from BSS). Limited to scope applicable for transport.</p>
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<p>No current Text</p>	<p>ADMINISTRATIVE REQUIREMENTS</p> <p>301 Any person intending to transport radioactive material shall inform the appropriate regulatory authority in accordance with the notification requirements of the Basic Safety Standards and shall obtain such authorizations as are appropriate.</p>	<p>BSS specifically requires notification for transport and may require authorization. This new provision is included and advisory text added to clarify that the requirements vary according to regulatory authority requirements.</p>
<p>305. For occupational exposures arising from transport activities, where it is assessed that the effective dose:</p> <p>(a) is most unlikely to exceed 1 mSv in a year, neither special work patterns nor detailed monitoring nor dose assessment programmes nor individual record keeping shall be required;</p> <p>(b) is likely to be between 1 and 6 mSv in a year, a dose assessment programme via work place monitoring or individual monitoring shall be conducted;</p> <p>(c) is likely to exceed 6 mSv in a year, individual monitoring shall be conducted.</p>	<p>RADIATION PROTECTION</p> <p>302. The applicable dose limits, individual monitoring requirements, health surveillance requirements for occupationally exposed workers and the appropriate additional provisions for radiological protection set out in the Basic Safety Standards [2] shall be complied with in the transport of radioactive materials.</p>	<p>Revision of 305 – heavily truncated to reference BSS as authoritative document for Radiation Protection. Revision of advisory text to ensure compatibility with RS-G-1.1.</p>
<p>302. In transport, protection and safety shall be optimized in order that the magnitude of individual doses, the number of persons exposed, and the likelihood of incurring exposure shall be kept as low as reasonably achievable, economic and social factors being taken into account, and doses to persons shall be below the relevant dose limits. A</p>	<p>303. In transport, protection and safety shall be optimized in order that the magnitude of individual doses, the number of persons exposed, and the likelihood of incurring exposure shall be kept as low as reasonably achievable, economic and social factors being taken into account, within the restriction that the doses to individuals be subject</p>	<p>Previous paragraph 302 modified to include dose constraints rather than dose limits (as in BSS). Advisory material added to explain application of constraints to global operations and particular operations..</p>

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<p>structured and systematic approach shall be adopted and shall include consideration of the interfaces between transport and other activities.</p> <p>301. A <i>Radiation Protection Programme</i> shall be established for the transport of <i>radioactive material</i>. The nature and extent of the measures to be employed in the programme shall be related to the magnitude and likelihood of radiation exposures. The programme shall incorporate the requirements of paras 302–303 and 305–309. Programme documents shall be available, on request, for inspection by the relevant <i>competent authority</i>.</p>	<p>to dose constraints. A structured and systematic approach shall be adopted and shall include consideration of the interfaces between transport and other activities.</p> <p>304. A <i>Radiation Protection Programme</i> shall be established for the transport of <i>radioactive material</i>. The nature and extent of the measures to be employed in the programme shall be related to the magnitude and likelihood of radiation exposures. The programme shall incorporate the requirements of paras 302–303 and 305–309. Programme documents shall be available, on request, for inspection by the relevant <i>competent authority</i>.</p>	<p>No change (ref added to advisory).</p>
<p>308. In the event of accidents or incidents during the transport of <i>radioactive material</i>, emergency provisions, as established by relevant national and/or international organizations, shall be observed to protect persons, property and the environment. Appropriate guidelines for such provisions are contained in Ref. [4].</p> <p>309. Emergency procedures shall take into account the formation of other dangerous substances that may result from the reaction between the contents of a <i>consignment</i> and the environment in the event of an accident.</p> <p>QUALITY ASSURANCE</p>	<p>EMERGENCY RESPONSE</p> <p>305. In the event of accidents or incidents during the transport of <i>radioactive material</i>, emergency provisions, as established by relevant national and/or international organizations, shall be observed to protect persons, property and the environment. Appropriate guidelines for such provisions are contained in Ref. [4].</p> <p>306. Emergency procedures shall take into account the formation of other dangerous substances that may result from the reaction between the contents of a <i>consignment</i> and the environment in the event of an accident.</p>	<p>No change (except para nos)</p>

QUALITY ASSURANCE	
<p>310. <i>Quality assurance</i> programmes based on international, national or other standards acceptable to the <i>competent authority</i> shall be established and implemented for the design, manufacture, testing, documentation, use, maintenance and inspection of all <i>special form radioactive material, low dispersible radioactive material</i> and <i>packages</i> and for transport and in-transit storage operations to ensure compliance with the relevant provisions of these Regulations. Certification that the <i>design</i> specification has been fully implemented shall be available to the <i>competent authority</i>. The manufacturer, <i>consignor</i> or user shall be prepared to provide facilities for <i>competent authority</i> inspection during manufacture and use and to demonstrate to any cognizant <i>competent authority</i> that:</p> <p>(a) the manufacturing methods and materials used are in accordance with the approved <i>design</i> specifications; and</p> <p>(b) all <i>packagings</i> are periodically inspected and, as necessary, repaired and maintained in good condition so that they continue to comply with all relevant requirements and specifications, even after repeated use.</p> <p>Where <i>competent authority approval</i> is required, such <i>approval</i> shall take into account and be contingent upon the adequacy of the <i>quality assurance</i> programme.</p>	<p>307. <i>Quality assurance</i> programmes based on international, national or other standards acceptable to the <i>competent authority</i> shall be established and implemented for the design, manufacture, testing, documentation, use, maintenance and inspection of all <i>special form radioactive material, low dispersible radioactive material</i> and <i>packages</i> and for transport and in-transit storage operations to ensure compliance with the relevant provisions of these Regulations. Certification that the <i>design</i> specification has been fully implemented shall be available to the <i>competent authority</i>. The manufacturer, <i>consignor</i> or user shall be prepared to provide facilities for <i>competent authority</i> inspection during manufacture and use and to demonstrate to any cognizant <i>competent authority</i> that:</p> <p>(a) the manufacturing methods and materials used are in accordance with the approved <i>design</i> specifications; and</p> <p>(b) all <i>packagings</i> are periodically inspected and, as necessary, repaired and maintained in good condition so that they continue to comply with all relevant requirements and specifications, even after repeated use.</p> <p>Where <i>competent authority approval</i> is required, such <i>approval</i> shall take into account and be contingent upon the adequacy of the <i>quality assurance</i> programme.</p>

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<p>COMPLIANCE ASSURANCE</p> <p>311. The <i>competent authority</i> is responsible for assuring compliance with these Regulations. Means to discharge this responsibility include the establishment and execution of a programme for monitoring the design, manufacture, testing, inspection and maintenance of <i>packaging, special form radioactive material and low dispersible radioactive material</i>, and the preparation, documentation, handling and stowage of <i>packages</i> by <i>consignors</i> and <i>carriers</i>, to provide evidence that the provisions of these Regulations are being met in practice.</p>	<p>COMPLIANCE ASSURANCE</p> <p>308. The <i>competent authority</i> is responsible for assuring compliance with these Regulations. Means to discharge this responsibility include the establishment and execution of a programme for monitoring the design, manufacture, testing, inspection and maintenance of <i>packaging, special form radioactive material and low dispersible radioactive material</i>, and the preparation, documentation, handling and stowage of <i>packages</i> by <i>consignors</i> and <i>carriers</i>, to provide evidence that the provisions of these Regulations are being met in practice.</p>	
<p>304. The relevant <i>competent authority</i> shall arrange for periodic assessments of the radiation doses to persons due to the transport of <i>radioactive material</i>, to ensure that the system of protection and safety complies with the Basic Safety Standards [2].</p> <p>SPECIAL ARRANGEMENT</p> <p>312. <i>Consignments</i> for which conformity with the other provisions of these Regulations is impracticable shall not be transported except under <i>special arrangement</i>. Provided the <i>competent authority</i> is satisfied that conformity with the other provisions of these Regulations is impracticable and that the requisite standards of safety established by</p>	<p>309. The relevant <i>competent authority</i> shall arrange for periodic assessments of the radiation doses to persons due to the transport of <i>radioactive material</i>, to ensure that the system of protection and safety complies with the Basic Safety Standards [2].</p> <p>SPECIAL ARRANGEMENT</p> <p>310. <i>Consignments</i> for which conformity with the other provisions of these Regulations is impracticable shall not be transported except under <i>special arrangement</i>. Provided the <i>competent authority</i> is satisfied that conformity with the other provisions of these Regulations is impracticable and that the requisite standards of safety established by</p>	<p>Moved – no other change.</p> <p>No change (except para nos)</p>

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<p>these Regulations have been demonstrated through means alternative to the other provisions, the <i>competent authority</i> may approve <i>special arrangement</i> transport operations for single or a planned series of multiple <i>consignments</i>. The overall level of safety in transport shall be at least equivalent to that which would be provided if all the applicable requirements had been met. For international <i>consignments</i> of this type, <i>multilateral approval</i> shall be required.</p>	<p>these Regulations have been demonstrated through means alternative to the other provisions, the <i>competent authority</i> may approve <i>special arrangement</i> transport operations for single or a planned series of multiple <i>consignments</i>. The overall level of safety in transport shall be at least equivalent to that which would be provided if all the applicable requirements had been met. For international <i>consignments</i> of this type, <i>multilateral approval</i> shall be required.</p>
<p>NON-COMPLIANCE</p>	<p>NON-COMPLIANCE</p>
<p>313. In the event of a non-compliance with any limit in these Regulations applicable to <i>radiation level</i> or <i>contamination</i></p>	<p>311. In the event of a non-compliance with any limit in these Regulations applicable to <i>radiation level</i> or <i>contamination</i></p>
<p>(a) the <i>consignor</i> shall be informed of the non-compliance by</p> <p>(i) the <i>carrier</i> if the non-compliance is identified during transport; or</p> <p>(ii) the <i>consignee</i> if the non-compliance is identified at receipt;</p>	<p>(a) the <i>consignor</i> shall be informed of the non-compliance by</p> <p>(i) the <i>carrier</i> if the non-compliance is identified during transport; or</p> <p>(ii) the <i>consignee</i> if the non-compliance is identified at receipt;</p>
<p>(b) the <i>carrier</i>, <i>consignor</i> or <i>consignee</i>, as appropriate shall:</p> <p>(i) take immediate steps to mitigate the consequences of the non-compliance;</p> <p>(ii) investigate the non-compliance and its causes, circumstances and consequences;</p>	<p>(b) the <i>carrier</i>, <i>consignor</i> or <i>consignee</i>, as appropriate shall:</p> <p>(i) take immediate steps to mitigate the consequences of the non-compliance;</p> <p>(ii) investigate the non-compliance and its causes, circumstances and consequences;</p>

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<p>(iii) take appropriate action to remedy the causes and circumstances that led to the non-compliance and to prevent a recurrence of similar circumstances that led to the non-compliance; and</p> <p>(iv) communicate to the relevant <i>competent authority(ies)</i> on the causes of the non-compliance and on corrective or preventive actions taken or to be taken; and</p> <p>(c) the communication of the non-compliance to the <i>consignor</i> and relevant <i>competent authority(ies)</i>, respectively, shall be made as soon as practicable and it shall be immediate whenever an emergency exposure situation has developed or is developing.</p>	<p>(iii) take appropriate action to remedy the causes and circumstances that led to the non-compliance and to prevent a recurrence of similar circumstances that led to the non-compliance; and</p> <p>(iv) communicate to the relevant <i>competent authority(ies)</i> on the causes of the non-compliance and on corrective or preventive actions taken or to be taken; and</p> <p>(c) the communication of the non-compliance to the <i>consignor</i> and relevant <i>competent authority(ies)</i>, respectively, shall be made as soon as practicable and it shall be immediate whenever an emergency exposure situation has developed or is developing.</p>	
<p>303. Workers shall receive appropriate training concerning the radiation hazards involved and the precautions to be observed in order to ensure restriction of their exposure and that of other persons who might be affected by their actions.</p> <p>TRAINING</p>	<p>312. Workers shall receive appropriate training concerning the radiation hazards involved and the precautions to be observed in order to ensure restriction of their exposure and that of other persons who might be affected by their actions.</p>	<p>No change (except para nos)</p>
<p>314. Persons engaged in the transport of <i>radioactive material</i> shall receive training in the contents of these Regulations commensurate with their responsibilities.</p> <p>TRAINING</p>	<p>313. Persons engaged in the transport of <i>radioactive material</i> shall receive training in the contents of these Regulations commensurate with their responsibilities.</p>	<p>No change (except para nos)</p>

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<p>315. Individuals such as those who classify <i>radioactive material</i>; pack <i>radioactive material</i>; mark and label <i>radioactive material</i>; prepare transport documents for <i>radioactive material</i>; offer or accept <i>radioactive material</i> for transport; carry or handle <i>radioactive material</i> in transport; mark or placard or load or unload packages of <i>radioactive material</i> into or from transport vehicles, bulk packagings or freight containers; or are otherwise directly involved in the transport of <i>radioactive material</i> as determined by the <i>competent authority</i>; shall receive the following training:</p> <p>(a) General awareness/familiarization training:</p> <ul style="list-style-type: none"> i. Each person shall receive training designed to provide familiarity with the general provisions of these Regulations; ii. Such training shall include a description of the categories of <i>radioactive material</i>; labeling, marking, placarding and packaging and segregation requirements; a description of the purpose and content of the <i>radioactive material</i> transport document; and a description of available emergency response documents; <p>(b) Function-specific training: Each person shall receive detailed training concerning specific <i>radioactive material</i> transport requirements which are applicable to the function that person performs;</p>	<p>314. Individuals such as those who classify <i>radioactive material</i>; pack <i>radioactive material</i>; mark and label <i>radioactive material</i>; prepare transport documents for <i>radioactive material</i>; offer or accept <i>radioactive material</i> for transport; carry or handle <i>radioactive material</i> in transport; mark or placard or load or unload packages of <i>radioactive material</i> into or from transport vehicles, bulk packagings or freight containers; or are otherwise directly involved in the transport of <i>radioactive material</i> as determined by the <i>competent authority</i>; shall receive the following training:</p> <p>(a) General awareness/familiarization training:</p> <ul style="list-style-type: none"> i. Each person shall receive training designed to provide familiarity with the general provisions of these Regulations; ii. Such training shall include a description of the categories of <i>radioactive material</i>; labeling, marking, placarding and packaging and segregation requirements; a description of the purpose and content of the <i>radioactive material</i> transport document; and a description of available emergency response documents; <p>(b) Function-specific training: Each person shall receive detailed training concerning specific <i>radioactive material</i> transport requirements which are applicable to the function that person performs;</p>	
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<p>(c) Safety training: Commensurate with the risk of exposure in the event of a release and the functions performed, each person shall receive training on:</p> <ul style="list-style-type: none"> i. Methods and procedures for accident avoidance, such as proper use of package-handling equipment and appropriate methods of stowage of radioactive material; ii. Available emergency response information and how to use it; iii. General dangers presented by the various categories of <i>radioactive material</i> and how to prevent exposure to those hazards, including if appropriate the use of personal protective clothing and equipment; and iv. Immediate procedures to be followed in the event of an unintentional release of <i>radioactive material</i>, including any emergency response procedures for which the person is responsible and personal protection procedures to be followed. 	<p>(c) Safety training: Commensurate with the risk of exposure in the event of a release and the functions performed, each person shall receive training on:</p> <ul style="list-style-type: none"> i. Methods and procedures for accident avoidance, such as proper use of package-handling equipment and appropriate methods of stowage of radioactive material; ii. Available emergency response information and how to use it; iii. General dangers presented by the various categories of <i>radioactive material</i> and how to prevent exposure to those hazards, including if appropriate the use of personal protective clothing and equipment; and iv. Immediate procedures to be followed in the event of an unintentional release of <i>radioactive material</i>, including any emergency response procedures for which the person is responsible and personal protection procedures to be followed. 	
<p>316. The training required by 315 shall be provided or verified upon employment in a position involving <i>radioactive material</i> transport and shall be periodically supplemented with retraining as deemed appropriate by the <i>competent authority</i>.</p>	<p>315. The training required by 314 shall be provided or verified upon employment in a position involving <i>radioactive material</i> transport and shall be periodically supplemented with retraining as deemed appropriate by the <i>competent authority</i>.</p>	

<p>306. <i>Radioactive material</i> shall be segregated sufficiently from workers and from members of the public. The following values for dose shall be used for the purpose of calculating segregation distances or <i>radiation levels</i>:</p> <p>(a) for workers in regularly occupied working areas a dose of 5 mSv in a year;</p> <p>(b) for members of the public, in areas where the public has regular access, a dose of 1 mSv in a year to the critical group.</p> <p>307. <i>Radioactive material</i> shall be sufficiently segregated from undeveloped photographic film. The basis for determining segregation distances for this purpose shall be that the radiation exposure of undeveloped photographic film due to the transport of <i>radioactive material</i> be limited to 0.1 mSv per <i>consignment</i> of such film.</p>	<p>TRANSPORT AND STORAGE IN TRANSIT</p> <p>Segregation during transport and storage in transit</p> <p>562. <i>Packages, overpacks and freight containers</i> containing <i>radioactive material</i> and unpacked <i>radioactive material</i> shall be segregated during transport and during storage in transit:</p> <p>(a) from workers in regularly occupied working areas by distances calculated using a dose criterion and model parameters compatible with the dose constraints that have been defined for the operations under the scope of the calculations;</p> <p>(b) from members of the critical group of the public, in areas where the public has regular access, by distances calculated using a dose criterion and model parameters compatible with the dose constraints that have been defined for the operations under the scope of the calculations;</p> <p>(c) from undeveloped photographic film by distances calculated using a radiation exposure criterion for undeveloped photographic film due to the transport of <i>radioactive material</i> of 0.1 mSv per <i>consignment</i> of such film; and</p> <p>(d) from other dangerous goods in accordance with para. 506.</p>	<p>Significant redraft and bringing together of segregation paragraphs (306, 307 562). Linking to dose constraints. Explanatory text added to explain history.</p> <p>Revised 562 (a) incorporates revised 306 (a)</p> <p>Revised 562 (b) incorporates revised 306 (b)</p> <p>Revised 562 (c) incorporates 307</p> <p>Provided extra references and justification of existing modal regulation segregation tables in advisory and explanatory.</p> <p>Explanatory text related to 0.7mSv dose constraint in global transport added.</p>
<p>562. <i>Packages, overpacks and freight containers</i> containing <i>radioactive material</i> shall be segregated during transport and during storage in transit:</p> <p>(a) from places occupied by persons and from undeveloped photographic film, for radiation exposure control purposes, in accordance with paras 306 and 307, and</p> <p>(b) from other dangerous goods in accordance with para. 506.</p>		

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Associated Draft Advisory and Explanatory Material

Major alterations marked in bold.

Section I

106.1. Transport includes carriage by a common carrier or by the owner or employee where the carriage is incidental to the use of the radioactive materials, such as vehicles carrying radiography devices being driven to and from the operations site by the radiographer, vehicles carrying density measuring gauges being driven to and from the construction site, and oil well logging vehicles carrying measuring devices containing radioactive materials and radioactive materials used in oil well injections.

107.1 The exemptions and exclusions from the scope are on the one hand generic exemptions and exclusions based on the principles of the Basic Safety Standards, and on the other hand relate to only the transport aspect of operations involving specific uses of materials, following the same principles. Exclusion from the Regulations is on the basis that exposures are essentially unamenable to control (e.g. K40 in the body). The specific items listed in 107 (a) – (f) and material not falling within paragraph 236 are deemed to be outside the scope of the Regulations, other radioactive material may only be excluded or exempted by the relevant regulatory authority.

107.2. The Regulations are not intended to be applied to movements of radioactive material that forms an integral part of a means of transport, such as depleted uranium counterweights or tritium exit signs used in aircraft; or to radioactive material in persons or animals for medical or veterinary purposes, such as cardiac pacemakers or radioactive material introduced into humans or animals for diagnosis or treatment. The treating physician or veterinarian should give appropriate advice on radiological safety.

107.3. Consumer products are items available to the general public as the end user without further control or restriction. These may be devices such as smoke detectors, luminous dials or ion generating tubes that contain small amounts of radioactive substances. Consumer products are outside the scope of the Regulations only after sale to the end user. Any transport, including the use of conveyances between manufacturers, distributors and

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retailers, is within the scope of the Regulations to ensure that large quantities of individually exempted consumer products are not transported in an unregulated manner.

107.4. The principles of exemption and their application to the transport of radioactive material are also dealt with in para. 401 **and 401.3 – 401.8.**

107.5. The scope of the Regulations includes consideration of those natural materials or ores which form part of the nuclear fuel cycle or which will be processed in order to use their radioactive properties. The Regulations do not apply to other ores which may contain naturally occurring radionuclides, but whose usefulness does not lie in the fissile, fertile or radioactive properties of those nuclides, provided that the activity concentration does not exceed 10 times the exempt activity concentration values. In addition, the Regulations do not apply to natural materials and ores containing naturally occurring radionuclides which have been processed (up to 10 times the exempt activity concentration values) where the physical and/or chemical processing was not for the purpose of extracting radionuclides, e.g. washed sands and tailings from alumina refining. **If this were not the case, the Regulations would have to be applied to enormous quantities of material that present a very low hazard. However, there are ores in nature where the activity concentration is much higher than the exemption values. The regular transport of these ores may require consideration of radiation protection measures. Hence, a factor of 10 times the exemption values for activity concentration was chosen as providing an appropriate balance between the radiological protection concerns and the practical inconvenience of regulating large quantities of material with low activity concentrations of naturally occurring radionuclides.**

107.6 The specific items listed in this paragraph and any other exempted or excluded sources of exposure or practices should be kept under regular review.

Section II

DEFINITIONS

220bis.1 This definition of dose constraint is taken from IAEA Safety Series 115, the Basic Safety Standards and is truncated to exclude medical exposures which are of no relevance to the Regulations.

Section III

GENERAL PROVISIONS

301.1 The Basic Safety Standards require notification by a wide range of users of radioactive material and specifically require notification where radioactive material is to be transported. This notification is important in that it aids competent authorities in the performance of their duties (e.g. paras 308; 309). Specific authorization for transport may not be required in some countries as this would be part of a generic authorization for holding radioactive material, and indeed authorization in addition to the approval requirements of the Regulations may not be required by the Regulatory Authority for the transport of radioactive material.

302.1. The Basic Safety Standards [1] set a limit on effective dose for the members of the public of 1 mSv/a, and for workers of 20 mSv, averaged over five consecutive years and not exceeding 50 mSv in a single year. Dose limits in special circumstances, dose limits in terms of equivalent dose for the lens of the eye, extremities (hand and feet) and skin, and dose limits for apprentices and pregnant women are also set out in the Basic Safety Standards and should be considered in the context of the requirements of para. 302 (e.g. I.17 and II-5 – II-8 of the Basic Safety standards). These limits apply to exposures attributable to all practices, with the exception of medical exposures and of exposures from certain natural sources.

302.2. Three categories for monitoring and assessing radiation doses **result from the guidance document at footnote 2**. The first category (**below 1mSv**) establishes a dose range where little action needs to be taken for evaluating and controlling doses. The upper value of this range is 1 mSv in a year, which was chosen to coincide with the dose limit for a member of the public. The second category has an upper value of 5 mSv/a. This level represents a reasonable dividing line between conditions where dose limits are unlikely to be approached and conditions where dose limits could be approached. The third category is for any situation where the occupational exposure may exceed the 5 mSv/a upper value in the second category.

Consideration should also be given to the likelihood and possible magnitude of potential exposures.

302.3. Many transport workers will be in the first category, and no specific measures concerning monitoring or control of exposure are required. **For individuals falling into the second category, a dose assessment programme will be necessary.** This may be based upon either individual monitoring or monitoring of the workplace. In the latter case, workplace monitoring may often be achieved by radiation level measurements in occupied areas at

the start and end of a particular stage of a journey. In some cases, however, air monitoring, surface contamination checks and individual monitoring may also be required. For individuals falling into the third category, individual monitoring **should be undertaken where appropriate, adequate and feasible**. In most cases this will be accomplished by the use of personal dosimetry such as film badges, thermo-luminescent dosimeters and, where necessary, neutron dosimeters (see also footnote 2).

302.4. Some studies of particular operations have shown a correlation between dose received by workers and the number of transport indexes handled [6]. It is unlikely that carriers handling less than 300 TI per year will exceed doses of 1 mSv/a and such carriers would not likely require detailed monitoring, dose assessment or individual records (**for example potential exposure considerations could affect this**).

302.5. Given that relatively high radiation levels are permitted during carriage under exclusive use, additional care should be taken to ensure that the requirements of para. 302 are met, since it would be relatively easy to exceed the 1 mSv level, and consequently specific measures regarding monitoring or control of exposures should be taken. In the assessment of the **overall individual exposure**, any exposures received during the carriage phase of transport should be considered together with those received elsewhere, particularly during loading and unloading.

302.6. The Basic Safety Standards [1] define radiological protection requirements for practices (activities that increase the overall exposure to radiation) and for intervention (activities that decrease the overall exposure by influencing the existing causes of exposure). The system of radiological protection for practices as set out in the Basic Safety Standards (Section 2, Principal Requirements) is summarized as follows:

—No practice is to be adopted unless it produces a positive net benefit (justification of a practice).

—All exposures are to be kept as low as reasonably achievable, economic and social factors being taken into account (optimization of protection).

—Total individual exposure is to be subject to dose limits or, in the case of potential exposures, to the control of risk (individual dose and risk limits).

302.7. In practical radiological protection there has in the past existed, and there continues to exist, a need to establish standards associated with quantities other than the basic dose limits. Standards of this type are normally known as secondary or derived limits.

302.8. Examples of associated standards in the Regulations include the maximum activity limits A_1 and A_2 , maximum levels for non-fixed contamination, radiation levels at the surfaces of packages and in their proximity, and segregation distances associated with the transport index. The Regulations require assessment and measurement to ensure that standards are being complied with.

303.1. Optimization of protection and safety requires that both normal and potential exposures be taken into account. Normal exposures are exposures that are expected to be received under routine and normal transport conditions as defined in para. 106 of the Regulations. Potential exposures are exposures that are not expected to be delivered with certainty but that may result from an accident or owing to an event or sequence of events of a probabilistic nature, including equipment failures and operating errors. In the case of normal exposures, optimization requires that the expected magnitude of individual doses and the number of people exposed be taken into account; in addition, in the case of potential exposures, the likelihood of the occurrence of accidents or events or sequences of events is also taken into account. Optimization should be documented in the RPPs. See also

Ref. [2] and footnote 2.

303.2 The constraints alluded to in these Regulations should be related to transport and in many cases it may be reasonable to set constraints for national or international transport of radioactive material on a mode specific basis rather than set constraints for individual shipments. In other cases it may be appropriate for individual users to include dose constraints in their radiological protection programme, in which case lower constraints would normally be expected to be set than for national or international transport. The constraints should be set bearing in mind the potential for workers and public to be exposed to other sources.

303.3. It should be a task of the competent authority to ensure that all transport activities are conducted under a general framework of optimization of protection and safety **and to ensure that appropriate dose constraints have been applied.**

304.1. The objectives of the Radiation Protection Programme (RPP) for the transport of radioactive material are:

- to provide for adequate consideration of radiation protection measures in transport;
- to ensure that the system of radiological protection is adequately applied;
- to enhance a safety culture in the transport of radioactive material; and
- to provide practical measures to meet these objectives.

The RPP should include, to the extent appropriate, the following elements:

- (a) scope of the programme (see paras 304.2–304.4);
- (b) roles and responsibilities for the implementation of the programme (see para. 304.5);
- (c) dose assessment (see para. 302);
- (d) surface contamination assessment (see paras 508, 513 and 514);
- (e) dose limits, dose constraints and optimization (see para. 302, 303);
- (f) segregation distances (see paras 562);
- (g) emergency response (see paras 305);
- (h) training (see para. 312-315); and
- (i) quality assurance (see para. 307).

304.2. The scope of the RPP should include all the aspects of transport as defined in para. 106 of the Regulations. However, it is recognized that in some cases certain aspects of the RPP may be covered in RPPs at the consigning, receiving or storage-in-transit sites. Since the magnitude and extent of measures to be employed in the RPPs will depend on the magnitude and likelihood of exposures, a graded approach should be followed.

304.3. Both the package type and the package category need to be considered. For routine transport the external radiation is important and the package category provides a classification for this; under accident conditions, however, it is the package type (Excepted, Industrial, Type A, Type B or Type C) that is important. Excepted, Industrial and Type A packages are not required to withstand accidents. For those aspects of the RPP related to accident conditions of transport, the possibility of leakage from these package types as the result of transport or handling accidents will need to be considered. In contrast, Type B and Type C packages can be expected to withstand all but the most severe accidents.

304.4. The external radiation levels from excepted packages and Category I-WHITE label packages are sufficiently low so as to be safe to handle without restriction, and a dose assessment is therefore unnecessary. Consideration of radiation protection requirements can be limited to keeping handling times as low as reasonably achievable, and segregation can be met by avoiding prolonged direct contact of packages with persons and other goods during transport. A dose assessment will, however, be needed for Category II- and III-YELLOW label packages, and segregation, dose limits, constraints and optimization will need to be considered in its light.

304.5. The RPP will best be established through the co-operative effort of consignors, carriers and consignees engaged in the transport of radioactive material. Consignors and consignees should normally have an appropriate RPP as part of fixed facility operations. The role and responsibilities of the different parties and individuals involved in the implementation of the RPP should be clearly identified and described. Overlapping of responsibilities should be avoided. Depending on the magnitude and likelihood of radiation exposures, the overall responsibility for establishment and implementation of the RPP may be assigned to a health physics or safety officer recognized through certification by appropriate boards or societies, or other appropriate means (e.g. by the relevant competent authorities), as a 'qualified expert' [1]. **A practical example of guidance on features that constitute a radiation programme has been published [NEW REF A].**

309.1. The competent authority assessments may be used to evaluate the effectiveness of the Regulations, including those for RPPs, and may be part of the compliance assurance activities detailed in Ref. [5] (see also paras 308.1–308.8). Of particular importance is the assessment of whether there is effective optimization of radiation protection and safety. This may also help in achieving and maintaining public confidence.

309.2. In order to comply with para. 309 of the Regulations, information on the radiation doses to workers and to members of the public should be collected and reviewed as appropriate. Reviews should be made if circumstances warrant, e.g. if significant changes in transport patterns occur or when a new technology related to radioactive material is introduced. The collection of relevant information may be achieved through a combination of radiation measurements and assessments. Reviews of accident conditions of transport are necessary in addition to those of routine and normal conditions.

312.1. The provision of information and training is an integral part of any system of radiological protection. The level of instruction provided should be appropriate to the nature and type of work undertaken. Workers involved in the transport of radioactive material require training concerning the radiological risks in their work and how they can minimize these risks in all circumstances.

312.2. Training should relate to specific jobs and duties, to specific protective measures to be undertaken in the event of an accident or to the use of specific equipment. It should include general information relating to the nature of radiological risk, knowledge of the nature of ionizing radiation, the effects of ionizing radiation and its measurement, as appropriate. Training should be seen as a continuous commitment throughout employment and involves initial training and refresher courses at appropriate intervals. The effectiveness of the training should be periodically checked.

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[NEW REF A] Either reference to IAEA RPP guide if published or:

UK Guidance on Radiation Protection Programmes for the Transport of Radioactive Material, National Radiological Protection Board,
<http://www.shipping.dft.gov.uk/trm/radiation/index.htm>

Section V
REQUIREMENTS AND CONTROLS FOR TRANSPORT

562.1. Operational controls that are applied during the transport of radioactive material can include the use of segregation distances. These generally take the form of tables relating the total transport index with the segregation distance, along with some time dependence. These tables are generally derived at a global or national level (for example the ICAO technical instructions) and include the effects of the operations of many consignors, shippers and carriers on either the most exposed worker or a critical group of the public. They are seldom derived on the basis of an individual consignor but such a use is within the scope of this regulation.

562.2 The history of the parameters used in the derivation of segregation tables is that originally a fraction of the dose limit was chosen in each case (for workers and members of the public) and what was considered to be a realistic model was used to derive the tables of segregation distances for each mode of transport. It was noted that real data was sparse and this should be reviewed. With the production of more realistic data [Refs 7 and 8 from section III and new refs B from NRPB due late 2002 road/rail, sea and air] it has become apparent that the models are very conservative. So conservative, that as the dose limits have been reduced the model and dose criteria have, on several re-examinations, been considered to provide adequate segregation. By comparing all aspects of the practice (not simply segregation) with appropriate dose constraints for transport (as a whole – not just for one transport operation) the use of the current tables have been deemed to provide an adequate level of safety.

562.3 An example of such a review was carried out during the preparation of the 1996 Edition of the Regulations. The model and dose criteria were examined in light of the developing philosophy of dose constraints as amplified in TECDOC 664 (the methodology of which is used in WS-G-2.3 “Regulatory control of radioactive discharges to the environment”). A dose constraint of 0.7mSv was considered appropriate for exposure of a critical group of the public to direct radiation from sources such as radioactive material in transport. This

constraint was envisaged as being applicable to global transport operations in general rather than the operations of one particular consignor. Over a series of three technical meetings information on assessed exposures to members of the public was actively collected and evaluated. The assessment of this information demonstrated that exposures being received by members of the public from these operations were far below the dose criterion used in the modelling and the appropriate dose constraint. And the conclusion of these studies was that the existing segregation tables and the other provisions of the Regulations together provided for an appropriate level of radiological safety. However these evaluations were not adequately reflected in the associated guidance document. It is the view that the current segregation tables are consistent with the use of appropriate dose constraints. For example, the “public” tables relate to 1mSv dose with a very pessimistic model (exposures are actually estimated to be of the order of 10s of microSv), not (as was intimated in the 1996 guidance) a realistic model.

562.4 **Dose criteria** of 5 mSv/a for occupationally exposed workers and of 1 mSv/a to the critical group [1] for members of the public were used for the purposes of calculating segregation distances or dose rates for regularly occupied areas in **international regulations** (see **Appendix III**). Recent studies [B] indicate that these values continue to be appropriate. The distances and dose rates are, for convenience, often presented in segregation tables. These dose **criteria** are for segregation distance or calculation purposes only and are required to be used together with hypothetical but **conservative** parameters in order to obtain appropriate segregation distances. Using the given values provides reasonable assurance that actual doses from the transport of radioactive materials will be well below the appropriate average annual dose limits.

562.5. The use of segregation distances does not in itself remove the requirement for **undertaking prior radiological evaluation, nor does it guarantee appropriate optimization for the transport of radioactive materials.**

562.6. **The dose criterion discussed above (5mSv/a and 1 mSv/a) have been used to calculate segregation tables applicable to overall transport operations (i.e. they include the activities of all transport practices). In some cases it may be appropriate for consignors and/or carriers to develop segregation tables applicable to individual shipments or transport campaigns. For those calculations the characteristics should be well defined and therefore the model may be more realistic. In these cases the associated dose criteria for public exposure will need to be**

revised downward significantly (this may also be the case for workers) to take into account the possibility of exposure to other transport operations (or other sources of exposure for workers). In any case the effect of segregation should be considered in relation to optimization within appropriate dose constraints.

562.7. There are many considerations and conditions specific to the transport mode which should be factored into the models used to calculate segregation distances. These include consideration of how the relationship between accumulated transport indices in a location and radiation levels in occupied areas is affected by shielding and distance, and how exposure times for workers and members of the public depend upon the frequency and duration of their travel in conjunction with radioactive material. These may be established by programmes of work using questionnaires, surveys and measurements. In some circumstances exposure for a short time close to packages, for example during inspection or maintenance work on sea voyages, can be more important than longer exposure times at lower dose rates in more regularly occupied areas. An example of the use of a model for determining minimum segregation and spacing distances for passenger and cargo aircraft is given in Appendix III.

562.8. Inevitably such calculations will be based on assumptions which may differ from real parameters in particular circumstances. Models should be robust and conservative. That the application of the resulting segregation distances leads to acceptably low doses is more important than the basis on which the distances were calculated. However, transport patterns are subject to change and doses should be kept under review.

562.9. The virtues of simplicity should not be ignored. Clear and simple requirements are more easily, and more likely to be followed, than complex, more rigorous ones. The simplified segregation table in the IMDG Code [10] giving practical segregation distances for different vessel types and the translation of the segregation distances of ICAO's Technical Instructions [12] by operators into TI limits per hold are good examples of this.

562.10. When calculating segregation distances for storage transit areas, the TI of the packages and the maximum time of occupancy should be considered. If there is any doubt regarding the effectiveness of the distance, a check may be made using appropriate instruments for the measurement of radiation levels.

562.11. If different classes of dangerous goods are being transported together, there is a possibility that the contents of leaking packages may affect adjacent cargo, e.g. a leak of corrosive material could reduce the effectiveness of the containment system for a package of radioactive material. Thus, in some cases it has been found necessary to restrict the classes of dangerous goods that may be transported near other classes. In some cases it may

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simply be stated which classes of dangerous goods must be segregated from others. In order to provide a complete and easy procedure for understanding the requirements, it has been found that presentation of this information in a concise tabular form is useful. As an example of a segregation table, the one included in Part 7 of the IMDG Code [10] is given here as Table II.

562.12. Although not a radiation protection issue, an evaluation of the effect of radiation on fast X ray films in 1947 [9] determined that they may show slight fogging after development when exposed to doses exceeding 0.15 mSv of gamma radiation. This could interfere with the proper use of the film and provide incorrect diagnostic interpretation. Other types of film are also susceptible to fogging although the doses required are much higher. Since it would be impracticable to introduce segregation procedures which vary with the type of film, the provisions of the Regulations are designed to restrict the exposure of undeveloped films of all kinds to a level of not more than 0.1 mSv during any journey from consignor to consignee.

562.13. The different time durations involved for sea transport (in terms of days or weeks) and air or land transport (in terms of hours or days) mean that different tables of segregation distances are used, so that the total film exposure during transit is the same for each mode. More than one mode of transport and more than one shipment may be involved in the distribution and ultimate use of photographic film. Thus, when segregation distance tables are being established for a specific transport mode, only a fraction of the limit prescribed in para. 562 should be committed to that mode. In road transport a driver may ensure sufficient segregation from photo-graphic film carried in other vehicles by leaving a clear space of at least 2 m all around the vehicle when parking.

562.14. Since mail bags often contain undeveloped film and will not be identified as such, it is prudent to protect mail bags in the same way as identified undeveloped film.

Appendix 5

Change #63

Supporting Information

**Establishing Risk-Informed Limits for Non-fixed Surface Contamination
On Spent Fuel Transportation Casks**

DRAFT REPORT

Establishing Risk-Informed Limits for Non-fixed Surface Contamination On Spent Fuel Transportation Casks

DRAFT REPORT

R. R. Rawl, K.F. Eckerman, J.S. Bogard, R.L. Coleman
Oak Ridge National Laboratory

J.R. Cook
Nuclear Regulatory Commission

April 2003

1. INTRODUCTION

The current limits for non-fixed contamination on packages used to transport radioactive materials were introduced in the 1961 edition of the International Atomic Energy Agency (IAEA) transport regulations, and were based on radiation protection guidance and practices in use at that time. The limits were based on exposure scenarios leading to intakes of radionuclides by inhalation and external irradiation of the hands. These considerations are collectively referred to as the Fairbairn model¹. Although formulated over forty years ago, the model remains unchanged and is still the basis of current regulatory derived limits on package non-fixed surface contamination.

In general, non-fixed contamination on the surface of a package can result in doses through the following pathways:

- Radiation emitted from the contaminated package surface and incident onto the body (direct exposure)
- Dispersal of the surface contamination into the air in a handling facility leading to subsequent
 - o Inhalation intakes
 - o Deposition onto the body and subsequent irradiation
- Transfer of contamination to the hands during handling of the packages leading to
 - o Irradiation of the hands
 - o Transfer of contamination from the hands to the face with irradiation of the face
 - o Ingestion of contamination from the hands
- Direct ingestion (which is considered sufficiently unlikely that it is not considered further)
- Dispersal into the environment
 - o Inhalation (including material resuspended following deposition)
 - o Deposition onto the body (including material resuspended following deposition)
 - o Ground shine (exposure to radiations emitted by contamination on the ground)
 - o Ingestion via the food chain

There can also be doses that, while not resulting directly from the contamination, are strongly influenced by and are attributable to regulatory requirements for contamination control. For example, actions necessary to comply with the current derived limits for light water reactor spent nuclear fuel (SNF) casks can result in significant external doses to workers. This is due to the relatively high radiation levels around the loaded casks where workers must function during the measurement of contamination levels and while decontaminating the cask. In order to optimize the total dose received due to compliance with cask contamination levels, it is necessary to take into account all the doses that vary as a result of the regulatory limit.

1.1 FAIRBAIRN MODEL ASSUMPTIONS

The Fairbairn model limits its consideration to inhalation of airborne contamination and transfer of contamination to the hands under a specified set of exposure scenarios. The permissible levels of contamination are constrained to not result in a) an airborne concentration greater than the maximum permissible concentration in air (MPCa) specified in the 1959 recommendations of the International Commission on Radiological Protection (ICRP)ⁱⁱ and b) contamination of the hands beyond what was considered to be good-practice in the 1960s. These constraints were applied to ²³⁹Pu (alpha emitter) and ⁹⁰Sr (beta emitter) that were considered the most hazardous alpha and beta emitting radionuclides at that time. Good practice regarding hand contamination was based on limiting the irradiation of the basal layer of the skin as the potential ingestion of contamination from the hands was found to be less restrictive. The model resulted in surface activity limits of 0.4 and 4 Bq/cm² for alpha and beta emitters, respectively.

1.2 SHORTCOMINGS OF THE FAIRBAIRN MODEL FOR LWR SNF PACKAGE SHIPMENTS

- The exposure scenarios of the model are characterized by conservative parametric values. This includes the resuspension factor ($4 \times 10^{-5} \text{ m}^{-1}$) and the exposure time (2000 h/y). This exposure time assumption is extremely conservative for SNF cask operations since only a fraction of the workers' time involves package preparation and shipment activities.
- The radiological parameters used in the model were taken from ICRP Publication 2, issued in 1959, and have, of course, been superseded by subsequent ICRP guidanceⁱⁱⁱ. Thus the model is not consistent with current practice. For example, current prospective planning constrains a worker's annual exposure to an effective dose³ of 20 mSv, not the 50 mSv value used in 1959. Although the effective dose constraint has been lowered, the applicable dose coefficients yield permissible workplace airborne concentrations for ²³⁹Pu and ⁹⁰Sr that are 3 and 30 times higher, respectively, than the maximum permissible air concentrations used in the model. Thus, the currently accepted ICRP dose coefficients would result in contamination limits 3 to 30 times higher assuming the same resuspension factors are used.
- Given the wide variation in magnitude of the dose coefficients among the radionuclides, a comprehensive model must be capable of addressing more than two radionuclides. The Fairbairn model relied on a high degree of conservatism in its selection of model parameters and by considering only the most restrictive alpha- and beta-emitting radionuclides (²³⁹Pu and ⁹⁰Sr). These radionuclides, while limiting, are inappropriate for LWR SNF packaging applications. The use of ¹³⁴Cs, ¹³⁷Cs, ⁵⁸Co and ⁶⁰Co are more appropriate for SNF applications as these are the radionuclides most

frequently encountered in significant quantities on casks surfaces following immersion in spent fuel pools.

- The inhalation intakes are based on a scenario occurring “in a confined space with conditions arranged to simulate very dusty conditions”¹. This approach is very conservative considering the conditions under which SNF packages are stored, prepared, and transported today.
- The Fairbairn model is based on a transport worker that works in the vicinity of packages continuously for 2000 hours per year. It does not take into account exposures to the:
 - Public during the course of transport
 - Workers preparing packages for transport

1.3 APPLICABILITY OF THE FAIRBAIRN MODEL TO SPENT FUEL CASKS

In summary, the Fairbairn model is based on exposure scenarios that are not appropriate for spent fuel casks. The exposure scenarios (hand contact without subsequent near-term monitoring or decontamination, dusty conditions, etc.) considered in the model are not representative of the operational practices and environments associated with handling of spent fuel casks. The model is based on the outdated critical organ approach to radiological protection that poorly, if at all, reflects actual health risk. The more recent ICRP recommendations are risk-based. Furthermore, the model has no provisions to consider the significant doses to workers resulting from efforts to achieve compliance with low surface contamination limits. Finally, the model does not consider doses to other groups such as members of the public.

Limits for non-fixed surface contamination on spent fuel casks should be established using a model that considers and optimizes the appropriate exposure scenarios both in the workplace and in the environment. The existing overly conservative limits lead to higher than optimal doses to persons, operational problems, non-compliance issues, and public perceptions of significant health risks when the actual risks are very low. A risk-informed approach is needed to ensure optimal use of personnel and material resources for SNF-based packaging operations.

2. SUMMARY OF OTHER STUDIES

The studies described in Appendix A - Summary of Selected Previous Contamination Studies contain previous work aimed at determining derived limit values for non-fixed surface contamination levels.

The NUREG study^{iv} includes both public dose and worker dose contributions to the total dose estimates. However, only limited dose pathways are considered and the data used in the study is outdated. The study indicates that for low direct exposure dose rate situations (1 mrem/h in the cask vicinity) it is possible to calculate an optimum additional decontamination time. This optimal time is dependent on the efficacy of the decontamination procedure, but appears to be about 20 additional minutes for an assumed decontamination factor of 10 for each 30 minutes of decontamination effort. On the other hand, the study also shows that for the envisioned scenarios with direct exposure rates of about 10 mrem/h (100 μ Sv/h) the optimal additional decontamination time is zero. That is, the total dose resulting from additional decontamination effort increases as additional work near the cask is performed (a very small decrease in public exposure due to the reduced contamination levels is greatly outweighed by the increase in worker exposure).

The NRPB study^v includes a limited number of pathways, but focuses on deriving contamination limits and does not include public dose contributions. The study does indicate derived limits of about 500-700 Bq cm⁻² are appropriate for typical radionuclides found in spent fuel applications.

The International Atomic Energy Agency has undertaken a Coordinated Research Project (CRP) on "Radiological Aspects of Package and Conveyance Non-Fixed Contamination". Technical contributions to the CRP include development of a model to calculate doses to the public and workers resulting from surface contamination for four different package types. The CRP developed to a set of dose pathways, exposure parameters, and calculational techniques for estimating the doses to workers and the public. Where possible, this report has attempted to use approaches that are consistent with the IAEA CRP. However, since the CRP model covers four package types (small manually handled, small remotely handled, large remotely handled, and spent fuel casks) it is more general in approach than this report (which deals solely with spent fuel casks). The CRP model does not take into account the doses received due to the contents of the spent fuel cask nor does it calculate collective doses to workers and the public which is necessary for examining optimization. As described in 4.3.1.2, doses to workers from the cask contents will vary as a function of the allowable contamination level since the time required to perform decontamination and contamination monitoring will vary. Consequently, some variations from the CRP approach have been made in order to include all significant dose pathways for spent fuel casks.

3. OPTIMIZATION

Compliance with radiation protection dose limits does not necessarily lead to realizing the benefit from a practice that requires radiation exposure to persons while, at the same time, keeping exposures to the lowest practicable levels. Radiation protection approaches such as "as low as reasonably achievable" (ALARA), "as low as practicable" (ALAP) and "optimization" have been incorporated into radiation protection principles as ways of achieving this objective.

The IAEA Basic Safety Standards^{vi} call for the optimization of protection and safety "[i]n relation to exposures from any particular source within a practice..." and states that "...protection and safety shall be optimized in order that the magnitude of individual doses, the number of people exposed and the likelihood of incurring exposures all be kept as low as reasonable achievable...within the restriction that the doses to individuals delivered by the source be subject to dose constraints." In the case of non-fixed surface contamination on spent fuel casks there are exposures to both workers and the public that must be taken into account.

3.1 TOTAL DOSE

Optimization of doses resulting from removable surface contamination on spent fuel casks requires considering all doses that could result from the contamination itself and doses that vary as a function of the allowable contamination limit. In this report, when evaluating the doses due to surface contamination, the doses due to the contents of the cask are ignored except where these doses vary due to the contamination limits. That is, where the doses due to the contents are the same regardless of the contamination limits, they are considered as a constant and are not factored into the evaluation.

The total effective dose due to removable surface contamination on the spent fuel casks can be expressed as:

$$E_{tot} = E_{wkr} + E_{pub} \quad (1)$$

where:

E_{tot} = total effective dose

E_{wkr} = effective dose to workers

E_{pub} = effective dose to the public

3.2 WORKER DOSE

The effective dose to workers is dependent on all the sources of exposure that vary as a function of the surface contamination limits. Since exposures due to decontamination and monitoring functions include both internal and external pathways, these must be considered in calculating worker exposure.

The effective dose to workers (E_{wkr}) can be expressed as:

$$E_{wkr} = E_{win} + E_{wex} \quad (2)$$

where:

E_{win} = effective dose to workers from internal exposure
 E_{wex} = effective dose to workers from external exposure

Some internal and all external worker doses will vary as a function of time spent near the cask. Since the time required to complete tasks necessary to comply with the surface contamination limits will vary with the contamination limits, these tasks must be considered separately when determining doses to workers. During these tasks, workers will be exposed to internal and external sources from both the cask itself and the work area.

E_{win} consists of all those contributors to internal exposure to workers when they are performing contamination-related work on the cask, and can be expressed as:

$$E_{win} = E_{wincask} + E_{winamb} \quad (3)$$

where:

$E_{wincask}$ = effective dose to workers due to internally deposited radionuclides originating from the cask surface

E_{winamb} = effective dose to workers due to internally deposited radionuclides from the ambient atmosphere in the work area

$E_{wincask}$ consists of two primary pathways by which contamination from the cask surface can be internally deposited in workers: inhalation of resuspended surface contamination; and, ingestion of contamination transferred from the cask surface to workers' hands and subsequently to the lips and mouth. This can be expressed as:

$$E_{wincask} = E_{wincaskinh} + E_{wincaskinges} \quad (4)$$

where:

$E_{wincaskinh}$ = effective dose to workers due to inhaled radionuclides

$E_{wincaskinges}$ = effective dose to workers due to ingested radionuclides

E_{wex} consists of all those contributors to external exposure to workers and can be expressed as:

$$E_{wex} = E_{wexcask} + E_{wexamb} \quad (5)$$

where:

$E_{wexcask}$ = effective dose to workers due to exposure to cask-related sources of external radiation

E_{wexamb} = effective dose to workers due to external exposure to ambient radiation in the work area

$E_{wexcask}$ consists of two cask-related pathways that can lead to worker exposure: direct external radiation from the contamination on the package surface; and, external radiation emanating from the cask itself (due to its radioactive contents). This can be expressed as:

$$E_{wexcask} = E_{wexcasksurf} + E_{wexcaskcon} \quad (6)$$

where:

$E_{wexcasksurf}$ = effective dose to workers due to direct external radiation from the contamination on the cask surface

$E_{wexcaskcon}$ = effective dose to workers due to external radiation from the cask contents

The equations for worker exposure, both internal and external, can be combined and simplified as:

$$E_{wkr} = E_{wincaskinh} + E_{wincaskinges} + E_{winamb} + E_{wexcasksurf} + E_{wexcaskcon} + E_{wexamb}$$

3.3 PUBLIC DOSE

The effective dose to the public can be expressed as:

$$E_{pub} = E_{pin} + E_{pex} \quad (7)$$

where:

E_{pin} = effective dose to the public due to internally deposited radionuclides originating from the cask surface

E_{pex} = effective dose to the public due to external exposure to removable contamination on the cask surface

The public dose due to surface contamination on a cask is not a function of the dose rate from the cask contents or the ambient (e.g., background) dose rate, since these doses do not vary as a function of the surface contamination. Since these exposures will not be affected by the surface contamination limits, they are not included in this study. The public dose pathways and dose calculations are presented in Section 5.

3.4 CALCULATION OF DOSES

Table 1 shows the variables that are included in this study of doses due to removable surface contamination on spent fuel casks.

Table 1. Doses that vary due to removable surface contamination on spent fuel casks

Total Dose (E_{tot})					
Dose to workers (E_{wkr})				Dose to the public (E_{pub})	
Worker internal dose (E_{win})		Worker external dose (E_{wex})			
		Public internal dose (E_{pin})		Public external dose (E_{pex})	
From cask contamination ($E_{wincask}$)		Ambient (E_{winamb})	From contamination and cask contents ($E_{wexcask}$)		Ambient (E_{wexamb})
Inhalation ($E_{wincaskinh}$)	Ingestion ($E_{wincaskinges}$)		Contam. on surface $E_{wexcasksurf}$	Cask contents $E_{wexcaskcon}$	

The radionuclide composition of cask surface contamination is dependent on several factors, but is most heavily influenced by the radionuclides present in the pool water in which the cask is immersed. Pool water radionuclide composition varies widely, so a reference pool water composition has been developed for this analysis using the values identified in the literature^{vii} and confirmed qualitatively with another nuclear plant operator^{viii}. Four primary contaminants were identified in LWR spent fuel pool water (^{134}Cs , ^{137}Cs , ^{58}Co and ^{60}Co). For the purposes of this study, the quantitative results reported in Ref. 7 have been used to derive a reference mix of contaminants on the cask surface that are proportional to their presence in the pool water, as shown in Table 2.

Table 2. Reference spent fuel pool water radionuclide composition

Radionuclide	Average activity in pool water ($\mu\text{Ci cm}^{-3}$)	Fraction of activity present
^{58}Co	6×10^{-4}	0.217
^{60}Co	2×10^{-3}	0.722
^{134}Cs	7×10^{-5}	0.025
^{137}Cs	1×10^{-4}	0.036

Using this mix of contaminants, it is possible to derive reference committed effective dose per unit intake factors for the mixture, using the fractions and dose per unit intake factors shown in Table 3. The committed effective dose per unit intake via inhalation for workers are those for $e(g)_{5\mu\text{m}}$ for lung absorption type M.

Table 3. Radionuclide characteristics for reference mixture of contaminants for workers

PROPOSED CHANGES FOR 120 DAY REVIEW

Radionuclide	Committed effective dose per unit intake via inhalation ⁶ (Sv Bq ⁻¹)		Committed effective dose per unit intake via ingestion ⁶ (Sv Bq ⁻¹)	Fraction of activity present
	Worker	Public	Worker	
⁵⁸ Co	1.4x10 ⁻⁹	1.6x10 ⁻⁹	7.4x10 ⁻¹⁰	0.217
⁶⁰ Co	7.1x10 ⁻⁹	1.0x10 ⁻⁸	3.4x10 ⁻⁹	0.722
¹³⁴ Cs	9.6x10 ⁻⁹	9.1x10 ⁻⁹	1.9x10 ⁻⁸	0.025
¹³⁷ Cs	6.7x10 ⁻⁹	9.7x10 ⁻⁹	1.3x10 ⁻⁸	0.036
Weighted Factor	5.9x10⁻⁹	8.2x10⁻⁹	3.6x10⁻⁹	

These weighted committed dose per unit intake factors are used in Sections 4 and 5 to calculate individual and collective doses for the exposure scenarios.

4. CALCULATION OF WORKER DOSE (E_{wkr})

Doses to workers resulting from removable contamination on the cask surface can result in both internal and external exposures. These can result from the following pathways:

- Internal (E_{win})
 - o Resuspension of the surface contamination into the air leading to subsequent inhalation intakes
 - o Transfer of contamination to the hands during handling of the packages leading to
 - Ingestion of contamination transferred from the hands to the lips and mouth
 - o Direct ingestion (which is considered sufficiently unlikely that it is not considered further)
- External (E_{wex})
 - o Radiation emitted from the contamination (external exposure)
 - o Cloudshine (irradiation by a "cloud" of resuspended contamination)
 - o Resuspension of the surface contamination into the air leading to subsequent deposition onto the body or clothing
 - o Deposition of resuspended activity onto the floor of the handling facility and subsequent irradiation from "groundshine"
 - o Transfer of contamination to the hands during handling of the packages leading to
 - Irradiation of the hands
 - Transfer of contamination from the hands to the face, resulting in irradiation of the skin of the face

The IAEA CRP has examined these pathways and has determined (with sample calculations) that the following pathways are "minor" and do not contribute significantly to worker dose:

- Cloudshine (irradiation by a "cloud" of resuspended contamination)
- Deposition of resuspended activity onto the floor of the handling facility
- Deposition of resuspended activity onto the skin
- Deposition of resuspended activity onto clothing

Consequently, these pathways are not considered further in this study.

Therefore, the remaining worker exposure pathways from removable surface contamination that are considered in this study are:

- Internal (E_{win})
 - o Resuspension of the surface contamination into the air leading to subsequent inhalation intakes (see 4.2.1.1)
 - o Transfer of contamination to the hands during handling of the packages leading to ingestion of contamination transferred from the hands (see 4.2.1.2)
- External (E_{wex}) (see 4.3.1.1)
 - o Radiation emitted from the contamination on the cask surface
 - o Transfer of contamination to the hands during handling of the packages leading to
 - Irradiation of the hands
 - Transfer of contamination from the hands to the face, resulting in irradiation of the skin of the face

Additionally, the following external doses received during decontamination and monitoring activities that will vary as a function of allowable contamination limits are considered:

- Radiation from the cask contents (see 4.3.1.2)
- Ambient (background) radiation in the work area (see 4.3.2)

4.1 WORKER EXPOSURE PARAMETERS

In order to calculate the total doses to workers due to the removable surface contamination limits, it is necessary to determine:

1. time and distances spent in the vicinity of the cask, and,
2. time spent in plant areas that result in doses due to ambient conditions

In the late 1980's and early 1990's, the Department of Energy sponsored several studies of doses resulting from spent fuel transportation, including those due to cask handling operations. These studies provide detailed breakdowns of cask handling operations, ambient dose rates in the areas where work is performed and resulting doses to workers. One study, DOE-CH/TPO-001, by Pacific Northwest Laboratory,^{ix} examined a postulated commercial spent fuel transportation system and is particularly useful in evaluating doses due to spent fuel cask handling operations.

DOE-CH/TPO-001 provides a breakdown of worker tasks by craft function, number of workers present, time spent in the work area and time spent near the cask. Using a reference cask and dose rate projections at various distances from the cask, the report develops dose estimates for each of the tasks and these can be summed to provide dose projections for an entire cask handling operation. Appendix B - Worker Parameters From DOE-TPO/CH-001 contains an extract from DOE-CH/TPO-001 that provides the details of the cask handling operations for a PWR and a BWR truck cask. A spreadsheet was developed from the worker time and motion information in DOE-CH/TPO-001 so that the information could be aggregated as needed.

4.2 EFFECTIVE DOSES TO WORKERS DUE TO INTERNALLY DEPOSITED RADIONUCLIDES (E_{win})

In this section worker doses due to inhalation and ingestion of removable surface contamination are calculated and worker doses due to ambient conditions are addressed.

4.2.1 Effective dose to workers due to internally deposited radionuclides from the cask surface ($E_{wincask}$)

4.2.1.1 Inhalation ($E_{wincaskinh}$)

Resuspension of the surface contamination into the air leading to subsequent inhalation intakes is a time dependent parameter. Using the approach adopted by the CRP, the airborne activity concentration ($Bq\ m^{-3}$) in a facility is given by:

$$C_d = \frac{RR \times A \times A_c}{V \times f_{ex}} \quad (8)$$

where:

RR = resuspension rate, $10^{-4}\ h^{-1}$

A = surface area of the cask from which resuspension occurs, $130\ m^2$ or $1.3 \times 10^6\ cm^2$

A_c = activity concentration on the package surface, $Bq\ cm^{-2}$

V = assumed room volume, 2,000 m³ (200 m² floor area x 10 m high)

f_{ex} = assumed air exchange rate, 2 h⁻¹

For a unit activity concentration on the cask surface (1 Bq cm⁻²), C_d is equal to 3.25x10⁻² Bq m⁻³.

Assuming that all resuspended activity is respirable (a conservative assumption) and that the airborne contamination is uniformly suspended in the defined volume near the cask, the committed effective dose from inhalation of resuspended activity from a cask is given by:

$$E = Cd \times T \times INH \times R_{10} \quad (9)$$

where:

C_d = airborne activity concentration, Bq m⁻³

T = exposure time, h

INH = breathing rate, taken as 1.2 m³ h⁻¹

R_{10} = inhalation dose coefficient for the reference contamination, 5.9x10⁻⁹ Sv Bq⁻¹ (see Section 3.4)

Equation 9 can be used to derive a committed effective dose per unit time:

$$\frac{E}{T} = Cd \times INH \times R_{10} \quad (10)$$

For the reference mixture of contaminants, this gives an inhalation annual committed effective dose per unit time of 2.3x10⁻¹⁰ Sv h⁻¹ from a unit activity concentration of 1 Bq cm⁻² on the cask surface.

From Appendix B, the individual worker that spends the most time on cask activities can be identified. Where more than one worker in a craft type is identified as being involved in a task (e.g., entry under "number doing cask work" is greater than 1), the workers in that craft type were divided in to worker number 1, number 2, etc.). Where only a single worker in a craft was identified for a given task, all the time was assigned to worker number 1 in that craft type.

If the 200 m² floor area used in Eqn 8 is assumed to be square and a cask diameter of 2.5 m is taken into account, all work performed within approximately 6 m (20 ft) of the cask is within the inhalation volume. Using the spreadsheet representation of Appendix B, it was determined that the worker that spends the most "activity time in minutes; in area" at a "work distance from cask in feet" of 20 feet or less, is OP1 (a reactor site operator) who has a total time of 14 hours in this area. Conservatively assuming that all of the time of OP1 is within the 2,000 m³ area of the suspended activity, the **maximum individual dose per cask turnaround due to inhalation is 3.2x10⁻⁹ Sv** per unit of surface activity concentration. The total time that workers are within 20 feet of the cask is approximately 41 person hours per cask turnaround (from receipt at the plant through dispatch from the plant). This results in **total worker exposure per turnaround due to inhalation of 9.4x10⁻⁹ person Sv**.

4.2.1.2 Ingestion ($E_{wincaskinges}$)

Transfer of contamination to the hands during handling of the packages leading to ingestion of contamination transferred from the hands is an event dependent exposure. Even though work processes in nuclear plants are likely to preclude hand contamination that leads

to ingestion of radionuclides, it is assumed that a worker's hands become contaminated once per cask handling day. The IAEA CRP approach for calculating worker committed effective dose due to ingestion is based on assuming that the transfer of contamination from the hands to the mouth is due to touching the lips and mouth from which the contamination is ingested. It is assumed that the area of the hands is 400 cm² and that 1% of the activity on the hands is ingested. This is equivalent to ingesting the contamination on 4 cm² of the hands. The equation for calculating ingestion dose is given by:

$$E = A_c \times area \times f \times f_{ing} \times R_9 \quad (11)$$

where:

A_c = activity concentration on the package surface, Bq cm⁻²

area = area of hands from which contamination is ingested, assumed to be 4 cm²

f = fraction of activity on the package transferred to the hands, 20%

f_{ing} = fraction ingested of contaminated hand area, 100%

R_9 = ingestion dose coefficient, 3.6x10⁻⁹ Sv Bq⁻¹ (see Section 3.4)

The **maximum individual dose per cask turnaround due to ingestion is 2.9x10⁻⁹ Sv** from a unit activity concentration on the cask surface (1 Bq cm⁻²). Based on the operational analysis in Appendix B there could be as many as 8 workers that perform cask operations that could lead to contact with the cask surface (4 OPs, 1 RM, and 3 MCs). Consequently, the **total worker exposure per turnaround due to ingestion is 2.3x10⁻⁸ person Sv**.

4.2.2 Effective dose to workers due to internally deposited radionuclides from the ambient atmosphere in the work area (E_{winamb})

Information from US utilities indicates that there is no significant ambient airborne radioactivity that could lead to measurable inhalation doses inside buildings. Therefore, this parameter is assumed to be negligible.

4.3 DOSES TO WORKERS DUE TO EXTERNAL EXPOSURE (E_{wex})

4.3.1 Effective dose to workers due to external exposure to removable contamination on the cask surface and from the cask itself ($E_{wexcask}$)

Workers can receive external exposures from:

- radiation originating from the contamination on the cask surface
- contamination on the hands
- contamination transferred from the hands to the face
- cask contents

4.3.1.1 External exposure from contamination on the cask ($E_{wexcasksurf}$)

Direct external exposure from contamination on the cask surface

Workers will be exposed to direct external radiation from the presence of contamination on the cask surface. Based on the results of the IAEA CRP, calculations with Microshield show that the dose rate from a unit activity surface contamination is highest from ⁶⁰Co, so the dose rates are based on this value. Based on an assumed flat vertical surface area of 14.2 m², the CRP-calculated dose rate at 1 m normal to the surface is 1.23x10⁻⁸ Sv h⁻¹ for 1

Bq cm⁻² of ⁶⁰Co. In order to calculate the external exposures to workers from the surface contamination, it is assumed that the dose rate decreases as a 1/r function of distance from the cask surface and dose rates are calculated for all tasks that take place at a distance of 50 ft (15 m) or less.

To determine the doses due to contamination, total worker time spent at each distance from the cask was summed from Appendix B. Since all workers will be exposed to the external radiation from the surface contamination and these doses will vary with the contamination limits, they are included. Some modification of the information in Appendix B was required in order to include only those steps where workers will receive external radiation exposure that varies with allowable contamination limits. For example, when the cask is in the spent fuel pool, workers are well shielded from any radioactive contamination on the cask surface and when the cask comes out of the pool, the contamination on the outer surfaces is dependent on the pool water cleanliness, not the transportation contamination limits. Consequently, steps 10 through 13 are not considered in this pathway.

Corresponding dose rates at the distances reported in Appendix B are shown in Table 4, along with the calculated total worker dose at each distance.

Table 4. Parameters and doses to workers due to external radiation from 1 Bq cm⁻² surface contamination of ⁶⁰Co (one cask turnaround cycle)

Distance (ft)	Distance (m)	Total worker time (h)	Dose rate (Sv h ⁻¹)	Total worker dose (person Sv)
1	0.3	1	4.1x10 ⁻⁸	4.1x10 ⁻⁸
3	0.9	16.3	1.4x10 ⁻⁸	2.3x10 ⁻⁷
5	1.5	8.95	8.2x10 ⁻⁹	7.3x10 ⁻⁸
6	1.8	1.2	6.8x10 ⁻⁹	8.2x10 ⁻⁹
8	2.4	0.67	5.1x10 ⁻⁹	3.4x10 ⁻⁹
10	3	4.25	4.1x10 ⁻⁹	1.7x10 ⁻⁸
20	6	7.6	2.1x10 ⁻⁹	1.6x10 ⁻⁸
30	9	4.25	1.4x10 ⁻⁹	6.0x10 ⁻⁹
38	11.5	0.25	1.1x10 ⁻⁹	2.8x10 ⁻¹⁰
50	15.2	0.33	8.1x10 ⁻¹⁰	2.7x10 ⁻¹⁰
Total				4.0x10 ⁻⁷

The worker times and dose rates applicable to performing cask decontamination and monitoring activities will vary with contamination limits. If allowable contamination limits are higher, the times required for decontamination activities would decrease and the external dose rate from the contamination will increase. The time and distance information in Appendix B was examined to identify the times and corresponding distances affected in this way. The following times (for steps 14.1, 14.2, 15.2, 19.1, 19.2, and 21.1 of Appendix B) were identified:

3 feet	110 minutes	1.8 hours
5 feet	45 minutes	0.75 hours
10 feet	45 minutes	0.75 hours

These doses constitute only about 10% of the doses shown in Table 4 and the offsetting effects of the reduced times are ignored when estimating the doses due to direct exposure to the surface contamination.

Consequently, the total worker dose per cask turnaround due to external radiation from surface contamination is 4.0x10⁻⁷ Sv from a unit activity concentration on the cask surface (1 Bq cm⁻²). The maximum individual worker exposure due to external radiation from surface contamination is OP1 with 1.8x10⁻⁷ Sv per cask turnaround.

External exposures to workers due to transfer of contamination

Transfer of contamination to the hands may lead to irradiation of the skin of the hands and possible subsequent transfer to the face with irradiation of the skin of the face. This dose pathway is unlikely due to the contamination control measures and work practices typically employed in nuclear power plants. However, it is included for completeness in estimating the potential doses to workers. The calculational approaches used here are derived from the CRP-developed approaches.

Hand contamination. During cask handling, workers typically wear gloves that will provide some shielding of beta emissions. Since the reference radionuclide mix for spent fuel cask contamination consists mainly of photon emitters, there is no assumed shielding due to the presence of gloves.

Assuming that outstretched hands have an area of 200 cm² on each side, and that contamination only occurs on the palm side following touching the cask, 400 cm² of 400 μm thick skin (palm side) will be contaminated^x. In the calculation of effective dose, it is assumed that the hands are contaminated for 8 hours per day. This assumes that a worker's hands are contaminated at the start of the working day, are decontaminated (by washing or removal of gloves) during a mid-day break, and re-contaminated during the afternoon. The contamination would be ultimately removed prior to exiting the radiologically controlled area.

DOE-CH/TPO-001 indicates that it typically requires approximately 1000 minutes (16.7 hours) elapsed time to turnaround a legal weight truck cask. Based on an 8-hour working shift, it is assumed that each worker receives hand irradiation for 2 days (16 hours) per cask turnaround.

The skin equivalent dose resulting from hand contamination is given by:

$$H_{SKIN\ HANDS} = A_c \times f \times T \times (\beta_{skin} + \gamma_{skin}) \quad (12)$$

where:

A_c = level of contamination, 1 Bq cm⁻²

f = fraction transferred, assumed to be 20%

T = time exposed, assumed to be 16 h per cask turnaround

β_{skin} = Skin equivalent dose rate to the basal layer of skin epidermis for beta irradiation for 400 μm thick skin, Sv h⁻¹ per Bq cm⁻²

γ_{skin} = Skin equivalent dose rate to the basal layer of skin epidermis for gamma irradiation, Sv h⁻¹ per Bq cm⁻²

Using the radionuclide mix described in Section 3.4, beta skin equivalent dose rates from Kocher and Eckerman^{xi}, and gamma skin equivalent dose rates from the CRP report, a weighted total (both beta and gamma) skin equivalent dose rate of 1.1x10⁻⁷ Sv h⁻¹ per Bq cm⁻² was calculated for 400 μm thick skin. From Eqn 12, this results in a skin equivalent dose of 3.5x10⁻⁷ Sv.

The effective dose from skin contamination due to touching the cask during handling is given by:

$$E_{SKIN} = H_{SKIN\ HANDS} \times w_{SKIN} \times \frac{\text{area exposed}}{\text{total area}} \quad (13)$$

where^{xii}:

$H_{SKIN\ HANDS} = 3.5 \times 10^{-7}$ Sv

w_{SKIN} = tissue weighting factor for skin, 0.01

area exposed = area of skin contaminated, here assumed to be 400 cm²

total area = total area of UVR exposed skin, 3000 cm²

This results in an **effective dose to an individual worker from contamination transferred to the hands of 4.7x10⁻¹⁰ Sv** from a unit surface activity per cask turnaround. Based on the operational analysis in Appendix B there could be as many as 8 workers that perform cask operations that could lead to contact with the cask surface (4 OPs, 1 RM, and 3 MCs). This results in a **collective effective dose to workers from contamination transferred to the hands of 3.8x10⁻⁹ Sv**.

Transfer of activity to the face. Other areas of skin, for example the face, could become contaminated indirectly from the contamination on the hands. In these calculations it is assumed (consistent with the CRP approach) that 4% (20% of 20%) of the activity level on the surface of the package is transferred from the hands to the face and the affected area of face is 100 cm², approximately the area of 1 cheek. An average exposure time of 8 hours per day has been assumed since the face may not be washed during the course of the day yet the contamination would be removed prior to exiting the radiologically controlled area. Based on an 8-hour working shift, it is assumed that each worker receives face irradiation for 2 days (16 hours) per cask turnaround.

The skin equivalent dose resulting from face contamination is given by:

$$H_{SKIN_FACE} = \chi \times f_{face} \times T \times (\beta_{skin} + \gamma_{skin}) \quad (14)$$

where: χ = activity of contamination available for transfer to the face:

$$\chi = A_c \times f$$

and, A_c = level of contamination, assumed to be 1 Bq cm⁻²

f = fraction transferred to the hands, assumed to be 20%

f_{face} = fraction transferred from the hands to the face, assumed to be 20%

T = time exposed, assumed to be 16 h per cask turnaround

β_{skin} = Skin equivalent dose rate to the basal layer of skin epidermis for beta irradiation for 40µm thick skin, Sv h⁻¹ per Bq cm⁻²

γ_{skin} = Skin equivalent dose rate to the basal layer of skin epidermis for gamma irradiation, Sv h⁻¹ per Bq cm⁻²

Using the radionuclide mix described in Section 3.4, beta skin equivalent dose rates from Kocher and Eckerman^{xiii}, and gamma skin equivalent dose rates from the CRP report, a weighted total (both beta and gamma) skin equivalent dose rate of 1.6x10⁻⁷ Sv h⁻¹ per Bq cm⁻² was calculated for 40 µm thick skin. From Eqn 14, this results in a skin equivalent dose of 1.0x10⁻⁹ Sv.

The effective dose from contamination of the face due to the transfer of contamination from the hands to the face is given by:

$$E_{SKIN} = H_{SKIN_FACE} \times w_{SKIN} \times \frac{area\ exposed}{total\ area} \quad (15)$$

where :

w_{SKIN_FACE} = tissue weighting factor for skin, 0.01 (NRPB, 1997)

area exposed = area of skin contaminated, here assumed to be 100 cm²

total area = total area of UVR exposed skin, 3000 cm² (NRPB, 1997)

This results in an **effective dose to an individual worker from contamination transferred from the hands to the face of 3.3x10⁻¹³ Sv** from a unit surface activity per cask turnaround. Based on the operational analysis in Appendix B there could be as many as 8 workers that perform cask operations that could lead to contact with the cask surface (4 OPs, 1 RM, and 3 MCs) and subsequent transfer of contamination to the face. This results in a **collective effective dose to workers from contamination transferred from the hands to the face of 2.6x10⁻¹² Sv**.

4.3.1.2 External exposure from the cask contents ($E_{wexcaskcon}$)

Workers will also be exposed to external radiation from the loaded cask, particularly when they are performing work near the cask. Appendix B provides details on the calculated doses to workers from the cask.

These worker doses include several steps that are tied directly to the efforts required to comply with the transport surface contamination limits, as shown in Table 5 below. Since the doses received from these steps will vary with the allowable contamination limits (less time is needed to comply with higher contamination limits), they are considered separately from the overall work flow of cask handling.

Table 5. Doses due to radiation from the cask contents as a result of cask decontamination and monitoring tasks

Step No.	Activity	Number and type of staff	Time near cask (h)	Dose due to cask work (person Sv)
14.1	Survey cask surface*	1 RM	0.25	1.8×10^{-6}
14.2	Decontaminate cask	2 OP	0.75	3.0×10^{-5}
15.2	Decontaminate area between lids	2 OP	0.08	3.3×10^{-5}
19.1	Radiation survey of cask and vehicle*	1 RM	0.5	5.3×10^{-5}
19.1	Radiation survey of cask and vehicle*	1 OP	0.4	2.3×10^{-5}
19.2	Spot decontamination	1 OP	0.17	5.0×10^{-5}
21.1	Radiation survey and recording*	1 RM	0.17	5.8×10^{-6}
21.1	Radiation survey and recording*	1 QC	0.17	5.8×10^{-6}
Total				2.0×10^{-4}

* These doses have been reduced 30% from the doses reported in Appendix B. This reduction is to account for approximately 30% of the reported dose in these tasks being attributable to radiation level measurement rather than contamination measurement.

Consequently, the **collective decontamination and monitoring worker dose per cask turnaround due to external radiation from the cask contents is 2.0×10^{-4} Sv**. The **maximum individual dose due to the cask contents is OP1 (assumed to be involved in all the OP tasks) with a dose of 1.0×10^{-4} Sv per cask turnaround**.

4.3.2 Effective dose to workers due to external exposure to ambient radiation in the work area (E_{wexamb})

When workers are performing cask-handling operations, they are also exposed to external ambient radiation from the work area. These worker doses include several steps that are tied directly to the efforts required to comply with the transport surface contamination limits, including those shown in Table 6 below. Since the doses due to ambient radiation levels in the work areas will vary with the allowable contamination limits (less time is needed to comply with higher contamination limits), they are considered separately from the overall work flow of cask handling.

Table 6. Doses due to radiation from the work area as a result of cask decontamination and monitoring tasks

Step No.	Activity	Number and type of staff	Time in area (h)	Dose due to ambient external radiation (person Sv)
14.1	Survey cask surface*	1 RM	0.33	4.7×10^{-6}
14.2	Decontaminate cask	2 OP	0.83**	1.7×10^{-5}
15.2	Decontaminate area between lids	2 OP	0.08	3.3×10^{-6}
19.1	Radiation survey of cask and vehicle**	1 RM	0.67	2.3×10^{-6}
19.1	Radiation survey of cask and vehicle**	1 OP	0.4	1.5×10^{-6}
19.2	Spot decontamination	1 OP	0.17	8.3×10^{-7}
21.1	Radiation survey and recording*	1 RM	0.5	1.8×10^{-6}
21.1	Radiation survey and recording*	1 QC	0.17	5.8×10^{-7}
Total				3.2×10^{-5}

* These doses have been reduced 30% from the doses reported in Appendix B. This reduction is to account for approximately 30% of the reported dose in these tasks being attributable to radiation level measurement rather than contamination measurement.

** The value for "time in area" reported in DOE-CH/TPO-001 appears to be in error since it is less than the time reported for near cask activities. This value has been revised to be the near cask time (0.75 h) plus 0.08 h to account for entry and exit from the area. This time correctly corresponds with the reported dose due to ambient external radiation.

The **collective decontamination and monitoring worker dose due to ambient external radiation is 3.2×10^{-5} Sv**. The maximum **individual dose due to ambient external radiation to workers performing decontamination and monitoring tasks occurs for OP1 who has a dose of 1.3×10^{-5} Sv per cask turnaround**.

4.4 SUMMARY OF WORKER DOSES

Using the results of Sections 4.2 and 4.3, the doses to workers resulting from the current contamination limits of 4 Bq cm^{-1} for beta- and gamma-emitters can be calculated. To calculate doses for internal and external exposures that are consistent with the CRP formulas (calculated for a unit activity concentration of 1 Bq cm^{-2}) and the external exposures derived from DOE-CH/TPO-001 (based on experience with cask operations designed to meet the current 4 Bq cm^{-2} limits), the values are normalized to 4 Bq cm^{-2} for a single PWR cask turnaround. These results are presented in Table 7 and Table 8.

Table 7. Individual dose to workers by all pathways

Individual dose to workers (E_{wkr}) in Sv – Normalized to 4 Bq cm^{-2}	
Worker internal dose (E_{win})	Worker external dose (E_{wex})

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From cask (contamination) ($E_{wincask}$)	Ambient (E_{winamb})	From cask (contamination and cask contents) ($E_{wexcask}$)	Ambient (E_{wexamb})
Inhalation: 1.3×10^{-8} Ingestion: 1.2×10^{-8} Total: 2.5×10^{-8}	N/A	From contamination: Direct – 7.2×10^{-7} Hand – 1.9×10^{-9} Face – 1.3×10^{-12} Total: 7.2×10^{-7}	1.3×10^{-5} (decon and monitoring only)
		From cask itself (decon and monitoring only) – 1.0×10^{-4}	

The results in Table 7 show that the doses to the maximally exposed individual worker can be categorized by:

1. doses that will increase if contamination limits are raised (inhalation, ingestion, and direct, hand, and face exposures) – these doses total 7.5×10^{-7} Sv per cask turnaround for a contamination level of 4 Bq cm^{-1}
2. doses resulting from decontamination and monitoring tasks that will decrease due to reduced exposure times if contamination limits are raised (from cask contents and ambient) – these doses total 1.1×10^{-4} Sv per cask turnaround for a contamination level of 4 Bq cm^{-1}

Table 8. Collective dose to workers by all pathways

Collective dose to workers (E_{wkr}) in Sv – Normalized to 4 Bq cm^{-2}			
Worker internal dose (E_{win})		Worker external dose (E_{wex})	
From cask (contamination) ($E_{wincask}$)	Ambient (E_{winamb})	From cask (contamination and cask contents) ($E_{wexcask}$)	Ambient (E_{wexamb})
Inhalation: 3.8×10^{-8} Ingestion: 9.2×10^{-8} Total: 1.3×10^{-7}	N/A	From contamination: Direct – 1.6×10^{-6} Hand – 1.5×10^{-8} Face – 1.0×10^{-11} Total: 1.6×10^{-6}	3.2×10^{-5} (decon and monitoring only)
		<i>From cask contents</i> (decon and monitoring only) – 2×10^{-4}	

The results in Table 8 show that the collective worker dose can be categorized by:

1. collective dose that will increase if contamination limits are raised (inhalation, ingestion, and direct, hand, and face exposures) – these doses total 1.7×10^{-6} Sv per cask turnaround for a contamination level of 4 Bq cm^{-1}
2. collective dose resulting from decontamination and monitoring tasks that will decrease due to reduced exposure times if contamination limits are raised (from cask contents and ambient) – these doses total 2.3×10^{-4} Sv per cask turnaround for a contamination level of 4 Bq cm^{-1}

4.5 WORKER DOSES AS A FUNCTION OF CONTAMINATION LIMITS

Based on the results in Section 4.4, it is possible to calculate the individual and collective worker doses that would increase due to higher contamination limits. These calculations have been performed for limits that are 10 and 100 times higher than the current limit of 4 Bq cm^{-1} for beta- and gamma-emitters, as shown in Table 9. The dose savings that would result from reduced decontamination and monitoring times and optimizing overall worker exposures are discussed in Section 6.

Table 9. Worker dose from higher removable contamination levels

Type of worker dose	Contamination limit	Dose
Individual	4	7.5×10^{-7} Sv
	40	7.5×10^{-6} Sv
	400	7.5×10^{-5} Sv
Collective	4	1.7×10^{-6} person Sv
	40	1.7×10^{-5} person Sv
	400	1.7×10^{-4} person Sv

5. CALCULATION OF PUBLIC DOSE

As described in Section 3.3, removable surface contamination on a cask surface can result in both internal and external exposures to members of the public. These doses can be calculated to determine the effect on both the collective public dose and the dose to the most exposed individual.

5.1 EFFECTIVE DOSES TO THE PUBLIC DUE TO INTERNALLY DEPOSITED RADIONUCLIDES

Removable surface contamination can be dispersed into the environment, leading to:

- o Inhalation
- o Deposition onto the body
- o Ground shine (exposure to radiations emitted by contamination on the ground)
- o Ingestion via the food chain

The IAEA CRP performed calculations to determine the magnitude of these exposures and determined that inhalation of contamination resuspended from the cask surface is the only significant internal dose pathway. The CRP focused on the maximum individual doses in relatively close proximities to the cask.

5.1.1 Exposure Scenarios

In order to accurately model doses to the public resulting from inhalation of contamination resuspended from the surface of a spent fuel cask during movement, it is necessary to define the scenarios leading to the exposures. The parameters in these scenarios vary from country to country and can be set to provide either country-specific results or more universal parameters can be set to support a more universal contamination dose model. While the doses from these exposures are extremely small, it is useful to calculate them in order to demonstrate that this exposure route is not a significant source of exposure to the public.

The exposure scenarios contained in the risk assessment code RADTRAN 5 provide insight into public exposure groups appropriate for incident-free transportation^{xiv}. In RADTRAN 5, the incident-free exposure scenarios include the following public groups:

1. off-link population (persons residing in the vicinity of the transport route)
2. on-link population (persons traveling in the vicinity of the shipment during transport)
3. population in the vicinity of the shipment during stops

These groups would also be the ones exposed to airborne contamination resuspended from the surface of a cask.

The characteristics of the reference spent fuel cask are consistent with the IAEA CRP and are assumed to be:

1. surface area of cask 130 m^2 ($1.3 \times 10^6 \text{ cm}^2$)
2. resuspension rate from cask surface 10^{-4} h^{-1} ($3 \times 10^{-8} \text{ s}^{-1}$)

Using these characteristics for a cask and a reference contamination level of 1 Bq cm^{-2} results in an activity release rate of $4 \times 10^{-2} \text{ Bq s}^{-1}$. As shown in Section 3.4, contamination on spent fuel casks consists of a mixture of radionuclides with a weighted committed effective dose per unit intake via inhalation for the public of $8.2 \times 10^{-9} \text{ Sv Bq}^{-1}$.

5.1.2 Public inhalation dose model

A dispersion model that takes into account dilution of the airborne activity due to mixing in the 'wake' of the moving conveyance was developed to calculate the doses to exposed individuals. The methodologies used in the model are provided in more detail in Appendix C. Doses can be calculated for individual members of the public as well as collective dose (if parameters for the route and population along the route are specified). The model calculates dose (Sv) per unit of surface contamination (1 Bq cm⁻²).

5.1.3 Off-link (persons residing in the vicinity of the transport route)

5.1.3.1 Dose to an individual

Ordinarily, the population along a route used to transport spent fuel lives some minimum distance away from the roadway or rail line. This minimum distance in the U.S. is typically 30 m for rural freeways, rural non-freeways and suburban freeways, and 27 m for suburban non-freeways.

The exposed population residing along a route will consist of some combination of persons indoors and outdoors (pedestrians, working, playing, etc.). For simplicity and to be conservative, all persons along the route are assumed to be outdoors when the shipment passes.

Using Eqn (C-3) of the model in Appendix C, the expected dose from surface contamination to the **most exposed individual at the edge of a road** when a cask passes by at 100 km h⁻¹ (30 m from the passing conveyance) is:

$$\begin{aligned}
 E &= Q \frac{\Psi}{Q} \dot{V} e \\
 &= \left(4 \times 10^{-2} \text{ Bq s}^{-1}\right) \left(2.49 \times 10^{-4} \text{ s}^2 \text{ m}^{-3}\right) \left(2.55 \times 10^{-4} \text{ m}^3 \text{ s}^{-1}\right) \left(8.2 \times 10^{-9} \text{ Sv Bq}^{-1}\right) \\
 &= 2.1 \times 10^{-17} \text{ Sv}
 \end{aligned}$$

5.1.3.2 Population dose

Analysis of a representative spent fuel transport route in the United States (Surry Nuclear Power Station, VA to Yucca Mountain, NV) using the ORNL Transportation Geographical Information System (TRAGIS) routing and population model shows that the route consists of 96% multilane divided highway and 4% other highway (two or more lanes, non-controlled access)^{xv}. The lengths of the route segments are: 4365 km multilane divided; and, 198 km other highways. The population within 800 m on either side of the centerline of the 4563 km route is 873,000 people. Assuming that the population is uniformly distributed within the band of land from 30 to 800 m on either side of the highway (to account for uninhabited rights-of-way), the land area over which the population is distributed is 7.0x10⁹ m² giving an average population density of 1.2x10⁻⁴ persons m⁻².

Using a 2-person crew, it takes the conveyance 47.5 hours to make the journey (1.7x10⁵ s). The time and distances spent on the two different road types is:

Type of road	Distance (km)	Transit time (s)
Multilane divided	4365	1.6×10^5
Other	198	7.1×10^3

Using Eqn (C-6) of the model in Appendix C, the collective dose for inhalation of resuspended contamination by the public residing along the route is calculated as follows:

Multilane divided highway

$$\begin{aligned}
 S &= \rho Q \frac{\bar{x}}{Q} \dot{V} (y_2 - y_1) v e t \\
 &= (1.2 \times 10^{-4} m^{-2}) (4 \times 10^{-2} Bq s^{-1}) (5.61 \times 10^{-7} s m^{-3}) (2.55 \times 10^{-4} m^3 s^{-1}) (770 m) (27.8 m s^{-1}) \\
 &\quad (8.2 \times 10^{-9} Sv Bq^{-1}) (1.6 \times 10^5 s) \\
 &= 1.9 \times 10^{-14} \text{ person Sv}
 \end{aligned}$$

Other highway

$$\begin{aligned}
 S &= \rho Q \frac{\bar{x}}{Q} \dot{V} (y_2 - y_1) v e t \\
 &= (1.2 \times 10^{-4} m^{-2}) (4 \times 10^{-2} Bq s^{-1}) (6.89 \times 10^{-7} s m^{-3}) (2.55 \times 10^{-4} m^3 s^{-1}) (770 m) (27.8 m s^{-1}) \\
 &\quad (8.2 \times 10^{-9} Sv Bq^{-1}) (7.1 \times 10^3 s) \\
 &= 1.0 \times 10^{-15} \text{ person Sv}
 \end{aligned}$$

Thus, the **total inhalation dose to the public along the route is 2×10^{-14} person Sv per cask shipment.**

5.1.4. On-link (persons traveling in the vicinity of the shipment during transport)

The exposed groups consist of:

- persons in vehicles following the shipment
- persons in vehicles traveling in the same direction as the shipment and passing it
- persons in vehicles traveling in the opposite direction to the shipment

Parameters were chosen to be representative of highway geometries and using the model in Appendix C, the following doses were calculated:

5.1.4.1 Individuals in vehicles following the shipment

Multilane divided highway

It is unlikely that a member of the public would follow a truck traveling at the speed limit on a divided highway for more than 4 hours (1.4×10^4 s) as this is the time at which the drivers would leave the highway to take a fuel or rest break. Applying Eqn (C-4) of the model in Appendix C (Fig. C-1, car #1) the dose to a member of the public following the cask for 4 hours would be:

$$\begin{aligned}
 E &= Q \frac{\bar{x}}{Q} \dot{V} e t \\
 &= (4 \times 10^{-2} Bq s^{-1}) (1.18 \times 10^{-4} s m^{-3}) (2.55 \times 10^{-4} m^3 s^{-1}) (8.2 \times 10^{-9} Sv Bq^{-1}) (1.4 \times 10^4 s) \\
 &= 1.4 \times 10^{-13} Sv
 \end{aligned}$$

Other highway

Assuming that a person in a car following the shipment on an undivided highway remains behind the shipment for the entire duration of the "other highway" portion of the journey (7.1×10^3 s):

$$\begin{aligned}
 E &= Q \frac{\dot{V}}{Q} e t \\
 &= \left(4 \times 10^{-2} \text{ Bq s}^{-1}\right) \left(1.18 \times 10^{-4} \text{ s m}^{-3}\right) \left(2.55 \times 10^{-4} \text{ m}^3 \text{ s}^{-1}\right) \left(8.2 \times 10^{-9} \text{ Sv Bq}^{-1}\right) \left(7.1 \times 10^3 \text{ s}\right) \\
 &= 7.0 \times 10^{-14} \text{ Sv}
 \end{aligned}$$

5.1.4.2 Individuals in vehicles passing the shipment in the same direction as the shipment

Multilane divided highway

Assuming that the passing vehicle is traveling at 5 km h^{-1} faster than the vehicle transporting the cask and applying Eqn (C-3) of the model in Appendix C (Fig. C-1, car #2) gives the following individual dose:

$$\begin{aligned}
 E &= Q \frac{\Psi}{Q} \dot{V} e \\
 &= \left(4 \times 10^{-2} \text{ Bq s}^{-1}\right) \left(9.79 \times 10^{-4} \text{ s}^2 \text{ m}^{-3}\right) \left(2.55 \times 10^{-4} \text{ m}^3 \text{ s}^{-1}\right) \left(8.2 \times 10^{-9} \text{ Sv Bq}^{-1}\right) \\
 &= 8.2 \times 10^{-17} \text{ Sv}
 \end{aligned}$$

Other highway

If it is assumed that a vehicle passing the shipment is traveling 5 km h^{-1} faster than the shipment when it is traveling on a non-divided highway and that the lane dimensions are equal, the dose to an individual on an "other" highway will be the same as for a multilane divided highway.

5.1.4.3 Individuals in vehicles traveling in the opposite direction to the shipment

Assuming the lane geometry and velocities given in Appendix C, the following individual doses can be calculated for an individual in these vehicles:

Multilane divided highway

There are two vehicles modeled, one in the nearest lane to the shipment (Fig. C-1, car #3) and one in the next lane removed (car #4). The **dose to an individual in car #3**, from Eqn (C-3), would be:

$$\begin{aligned}
 E &= Q \frac{\Psi}{Q} \dot{V} e \\
 &= \left(4 \times 10^{-2} \text{ Bq s}^{-1}\right) \left(1.75 \times 10^{-4} \text{ s}^2 \text{ m}^{-3}\right) \left(2.55 \times 10^{-4} \text{ m}^3 \text{ s}^{-1}\right) \left(8.2 \times 10^{-9} \text{ Sv Bq}^{-1}\right) \\
 &= 1.5 \times 10^{-17} \text{ Sv}
 \end{aligned}$$

Similarly, the **dose to an individual in car #4** would be proportional to the integrated concentration per unit release rate for car #3:

$$E = \left(\frac{1.54 \times 10^{-4}}{1.75 \times 10^{-4}} \right) (1.5 \times 10^{-17})$$

$$= 1.3 \times 10^{-17} \text{ Sv}$$

Other highway

Also according to Eqn (C-3) of Appendix C, the **dose to an individual in a vehicle traveling in the opposite direction as the shipment in the adjacent lane** would be:

$$E = (4 \times 10^{-2} \text{ Bq s}^{-1}) (3.9 \times 10^{-4} \text{ s}^2 \text{ m}^{-3}) (2.55 \times 10^{-4} \text{ m}^3 \text{ s}^{-1}) (8.2 \times 10^{-8} \text{ Sv Bq}^{-1})$$

$$= 3.3 \times 10^{-17} \text{ Sv}$$

5.1.4.4 On-link collective doses due to inhalation

With the exception of cars following the transport vehicle, the collective dose to on-link persons is influenced by the number of cars approaching or passing the transport vehicle, the assumed occupancy of the cars, and the individual doses as calculated in previous sections. The modeling algorithms developed in Appendix C were applied to calculate on-link collective doses and are described in more detail in Appendix D.

It was assumed that vehicles sharing the highway were following each other with a minimum separation distance of 55 m and that the traffic stream was continuous in both directions. This very conservative traffic density over the entire route was offset with an assumption of one person per vehicle. A spreadsheet analysis was performed as described in Appendix D and the results are shown in Table 10:

Table 10 - On-Link Collective Inhalation Doses

Exposed Group	Lane number	Persons affected	E (person Sv)
Following shipment – multilane and other highway	1	100	4.9×10^{-13}
Passing in same direction – multilane and other highway	2	3,968	4.0×10^{-13}
Traveling in opposite direction – multilane near lane	3	162,695	2.9×10^{-12}
Traveling in opposite direction – multilane far lane and other highway (with corrected geometry)	4	165,927	2.8×10^{-12}
Total			6.6×10^{-12}

5.1.5. Doses due to inhalation at stops

The IAEA CRP examined doses to members of the public during stops at distances ranging from 5 to 50 meters. The geometric approach used in the CRP was appropriate for

relatively short distances but is not suitable for longer distances unless modifications in the methodology are made to account for additional atmospheric effects. Based on analysis of the CRP approach, modifications were made to that allow extrapolation of the approach out to 800 meters. This permitted the development of results that are as consistent as possible with the CRP results while providing the dose estimates at longer distances required for calculating the collective internal public dose.

Details of how the CRP approach was extrapolated to longer distances are provided in Appendix E - Inhalation Population Dose from Contamination at Stops. The approaches described in the appendix were incorporated into a spreadsheet that calculated the doses.

Assuming a population density as described in 5.1.3.2 and that there are 11 one-half hour stops during the journey (approximately one stop every 4 hours), in the band of population from 5 to 800 m the **collective population dose from inhalation during stops is 3.5×10^{-13} person Sv**. It is unlikely that an individual would be present at more than one stop during the shipment (resulting in one-half hour exposure time per shipment) and the distance at which the exposure occurs is assumed to be relatively close (5 m), resulting in a **maximum individual dose from inhalation of 3.3×10^{-14} Sv**.

5.1.6. Summary of public doses due to inhalation

From the previous results, it can be seen that the doses to members of the public from the inhalation of resuspended contamination from a cask surface is very low. The results are provided in Table 11 and Table 12.

Table 11. Inhalation doses to the maximum exposed member of the public

Exposure scenario	Individual dose (Sv per cask shipment)
5.1.3.1 Individual at 30 m from route	2.1×10^{-17}
5.1.4.1 Following the shipment – multilane	1.4×10^{-13}
5.1.4.1 Following the shipment – other highway	7.0×10^{-14}
5.1.4.2 Passing shipment in same direction – multilane or other highway	8.2×10^{-17}
5.1.4.3 Traveling in opposite direction – multilane near lane	1.5×10^{-17}
5.1.4.3 Traveling in opposite direction – multilane far lane	1.3×10^{-17}
5.1.4.3 Traveling in opposite direction – other highway	3.3×10^{-17}
5.1.5 At stops	3.3×10^{-14}
Highest individual public inhalation dose (1 Bq/cm^2)	1.4×10^{-13}

Table 12. Inhalation collective dose to the public

Exposure scenario	Collective dose (person Sv per cask shipment)
5.1.3.2 Population 30 – 800 m from route	2.0×10^{-14}

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5.1.4.4 Following the shipment – multilane and other highway	4.9×10^{-13}
5.1.4.4 Passing shipment in same direction – multilane and other highway	4.0×10^{-13}
5.1.4.4 Traveling in opposite direction – multilane near lane	2.9×10^{-12}
4.3.1 Traveling in opposite direction – multilane far lane and other highway (with corrected geometry)	2.8×10^{-12}
5.1.5 At stops	3.5×10^{-13}
Total collective public inhalation dose (1 Bq cm⁻²)	7×10^{-12}

5.2 DOSES TO THE PUBLIC DUE TO EXTERNAL EXPOSURES

5.2.1 Exposure Scenarios

Since there will be direct external exposures to members of the public from the contamination on the cask surface with exposure scenarios as described earlier for inhalation, these doses have been calculated.

5.2.2 Public external dose model

The methodologies used in the model are provided in more detail in Appendix F - External Exposures to Members of the Public. Using the approach described in the appendix, a spreadsheet was developed and used to calculate doses for individual members of the public as well as collective dose (using specified parameters for the route and population). The model calculates dose (Sv) per unit of surface contamination (1 Bq cm^{-2}).

5.2.3 Off-link population (persons residing in the vicinity of the transport route)

5.2.3.1 Dose to an individual

Ordinarily, the population along a route used to transport spent fuel lives some minimum distance away from the roadway or rail line. This minimum distance in the U.S. is typically 30 m for rural freeways, rural non-freeways and suburban freeways, and 27 m for suburban non-freeways.

The exposed population residing along a route will consist of some combination of persons indoors and outdoors (pedestrians, working, playing, etc.). For simplicity and to be conservative, all persons along the route are assumed to be outdoors when the shipment passes.

The maximum expected dose to a person along the transport route resulting from 1 Bq cm^{-1} surface contamination occurs when a cask passes by at 27 m from a person. The **maximum off-link individual dose is $1.4 \times 10^{-14} \text{ Sv}$** .

5.2.3.2 Population dose

Analysis of a representative spent fuel transport route in the United States (Surry Nuclear Power Station, VA to Yucca Mountain, NV) using the ORNL Transportation Geographical Information System (TRAGIS) routing and population model shows that the route consists of 96% multilane divided highway and 4% other highway (two or more lanes, non-controlled access)^{xv}. The lengths of the route segments are: 4365 km multilane divided; and, 198 km other highways. The population within 800 m on either side of the centerline of the 4563 km route is 873,000 people. Assuming that the population is uniformly distributed within the band of land from 30 to 800 m on either side of the highway (to account for uninhabited rights-of-way), the land area over which the population is distributed is $7.0 \times 10^9 \text{ m}^2$ giving an average population density of $1.2 \times 10^{-4} \text{ persons m}^{-2}$.

Using a 2-person crew, it takes the conveyance 47.5 hours to make the journey ($1.7 \times 10^5 \text{ s}$). The time and distances spent on the two different road types is:

Type of road	Distance (km)	Transit time (s)
Multilane divided	4365	1.6×10^5
Other	198	7.1×10^3

Multilane divided highway

The calculation of collective dose to persons along the route due to direct external exposure to the surface contamination must take into account the greater distance that the population is away from the cask on the far side of a multilane divided highway. The resulting collective dose is:

- population nearest the shipment 1.0×10^{-9} person Sv
- population opposite the shipment 7.5×10^{-10} person Sv
- Total multilane collective dose 1.8×10^{-9} person Sv

Other highway

Exposure distances are slightly shorter for other highways (27 vs. 30 m) but the much shorter distances and lower population counts result in much lower collective doses along these segments:

- population nearest the shipment 4.8×10^{-11} person Sv
- population opposite the shipment 4.5×10^{-11} person Sv
- Total multilane collective dose 9.3×10^{-11} person Sv

Thus, the **collective off-link dose to the public from 1 Bq cm⁻² of surface contamination is 1.9×10^{-9} person Sv per cask shipment.**

5.2.4. On-link (persons traveling in the vicinity of the shipment during transport)

The exposed groups consist of:

- persons in vehicles following the shipment
- persons in vehicles traveling in the same direction as the shipment and passing it
- persons in vehicles traveling in the opposite direction to the shipment

Parameters were chosen to be representative of highway geometries. Using the model in Appendix F, the doses in Sections 5.2.4 and 5.2.5 were calculated.

5.2.4.1 Individuals in vehicles following the shipment

Multilane divided highway

It is unlikely that a member of the public would follow a truck traveling at the speed limit on a divided highway for more than 4 hours (1.4×10^4 s) as this is the time at which the drivers would leave the highway to take a fuel or rest break. The **maximum external dose to an individual following the shipment on a multilane highway is 1.6×10^{-11} Sv.**

Other highway

Assuming that a person in a car following the shipment on an undivided highway remains behind the shipment for the entire duration of the "other highway" portion of the

journey (7.1×10^3 s), the **maximum dose to an individual following the shipment on an "other" highway is 1.2×10^{-11} Sv.**

5.2.4.2 Individuals in vehicles passing the shipment in the same direction as the shipment

Multilane divided highway

Assuming that the passing vehicle is traveling at 5 km h^{-1} faster than the vehicle transporting the **maximum individual dose when passing the shipment is 1.9×10^{-12} Sv.**

Other highway

If it is assumed that a vehicle passing the shipment is traveling 5 km h^{-1} faster than the shipment when it is traveling on a non-divided highway and that the lane dimensions are equal, the dose to an individual is the same (1.9×10^{-12} Sv).

5.2.4.3 Individuals in vehicles traveling in the opposite direction to the shipment

Assuming the lane geometry and velocities given in Appendix C and using the approaches described in Appendix F, individual doses were calculated.

Multilane divided highway

There are two vehicles modeled, one in the nearest lane to the shipment and one in the next lane removed. The **dose to an individual in car #4 traveling in the opposite direction as the shipment is 7.2×10^{-15} Sv** and the dose to an individual in car #3 is 8.2×10^{-15} .

Other highway

The **maximum dose to an individual in a vehicle traveling in the opposite direction as the shipment in the adjacent lane is 4.8×10^{-14} Sv.**

5.2.4.4 On-link collective doses due external exposures

Using the same assumptions described in Section 5.1.4.4, collective doses due to external radiation were calculated as described in Appendix F and are shown in Table 13.

Table 13. Collective on-link doses due to external radiation

Exposed Group	Lane number	Persons affected	<i>E</i> (person Sv)
Following shipment – multilane and other highway	1	100	1.9×10^{-10}
Passing in same direction – multilane and other highway	2	3,968	8.1×10^{-9}
Traveling in opposite direction – multilane near lane	3	162,695	1.3×10^{-9}
Traveling in opposite direction – multilane far lane and other highway (with corrected	4	165,927	1.1×10^{-9}

geometry)			
Total			1.1x10⁻⁸

5.2.5. Doses due to external exposures at stops

In a manner similar to that in described in Section 5.1.5, the IAEA CRP approach was extended to allow calculation of individual and collective doses to the public from external radiation during stops. Details of how the CRP approach was extrapolated to longer distances and how they were used to calculate collective dose are provided in Appendix F. The approaches described in the appendix were incorporated into a spreadsheet that calculated the doses.

Assuming a population density as described in 5.1.3.2 and that there are 11 one-half hour stops during the journey (approximately one stop every 4 hours), in the band of population from 5 to 800 m the **collective population dose from external exposure during stops is 8.8x10⁻⁹ person Sv**. It is unlikely that an individual would be present at more than one stop during the shipment (resulting in one-half hour exposure time per shipment) and the distance at which the exposure occurs is assumed to be relatively close (5 m), resulting in a **maximum individual dose from external exposure during stops of 2.5x10⁻¹⁰ Sv**.

5.2.6. Summary of public doses due to external exposure

From the previous results, it can be seen that the doses to members of the public from direct exposure to contamination on a cask surface, while higher than those for inhalation, are still very low. These dose calculations (as described in Appendix F) are summarized below for the same reference route used in Section 5.1 and a surface activity concentration of 1 Bq cm⁻².

Table 14. External exposure dose to the maximum exposed individual member of the public

Exposure scenario	Individual dose (Sv per cask shipment)
5.2.3.1 Individual at 30 m from route	1.4 x 10 ⁻¹⁴
5.2.4.1 Following the shipment – multilane	1.6x10 ⁻¹¹
5.2.4.1 Following the shipment – other highway	1.2x10 ⁻¹¹
5.2.4.2 Passing shipment in same direction – multilane or other highway	1.9x10 ⁻¹²
5.2.4.3 Traveling in opposite direction – multilane near lane	8.2x10 ⁻¹⁵
5.2.4.3 Traveling in opposite direction – multilane far lane	7.2x10 ⁻¹⁵
5.2.4.3 Traveling in opposite direction – other highway	4.8 x 10 ⁻¹⁴
5.1.5 At stops	2.5x10 ⁻⁹
Highest individual public external dose (1 Bq/cm⁻²)	2.5x10⁻⁹

Table 15. External exposure collective dose to the public

Exposure scenario	Collective dose (person Sv per cask shipment)
--------------------------	--

5.2.3.2 Population 30 – 800 m from route	1.9×10^{-9}
5.1.4.4 Following the shipment – multilane and other highway	1.9×10^{-10}
5.1.4.4 Passing shipment in same direction – multilane and other highway	8.1×10^{-9}
5.1.4.4 Traveling in opposite direction – multilane near lane	1.3×10^{-9}
4.3.1 Traveling in opposite direction – multilane far lane and other highway (with corrected geometry)	1.1×10^{-9}
5.2.5 At stops	8.8×10^{-9}
Total collective public external dose (1 Bq cm^{-2})	2.1×10^{-8}

5.3 PUBLIC DOSES FROM HIGHER CONTAMINATION LIMITS

The results of Sections 5.1 and 5.2 can be extrapolated to predict the maximum individual and collective public doses that would result from higher contamination levels. The public doses from higher contamination levels for are shown in Table 16.

Table 16. Collective and individual doses from higher contamination levels

Exposure Type	Contamination Value (Bq cm^{-2})	Collective Dose (Sv)	Maximum Exposed Individual Dose (Sv)
Internal	1	7×10^{-12}	1.4×10^{-13}
	4	2.8×10^{-11}	5.6×10^{-13}
	40	2.8×10^{-10}	5.6×10^{-12}
	400	2.8×10^{-9}	5.6×10^{-11}
External	1	2.1×10^{-8}	2.5×10^{-9}
	4	8.4×10^{-8}	1.0×10^{-8}
	40	8.4×10^{-7}	1.0×10^{-7}
	400	8.4×10^{-6}	1.0×10^{-6}

For a single cask shipment, the increase in public dose (combined off-link and on-link) due to higher allowable contamination limits is shown in Table 17.

Table 17. Increases in public doses due to higher contamination levels

Exposure Type	Contamination Value (Bq cm^{-2})	Increase in Collective Dose (person Sv)	Increase in Maximum Exposed Individual Dose (Sv)
Internal	4	0	0
	40	2.5×10^{-10}	5.0×10^{-12}
	400	2.8×10^{-9}	5.5×10^{-11}
External	4	0	0
	40	7.6×10^{-7}	9.0×10^{-8}
	400	8.3×10^{-6}	9.9×10^{-7}

The total collective public dose increases (combined internal and external doses) due to higher contamination levels are dominated by the external collective dose (3 orders of magnitude). The increase in collective dose to the public is almost entirely due to exposure to external radiation originating from contamination on the cask surface. Resuspension of removable surface contamination and subsequent inhalation by members of the public is not a significant contributor to the collective public dose.

6. OPTIMIZING SPENT FUEL CONTAMINATION LIMITS

6.1 EFFECT OF ALLOWABLE CONTAMINATION LIMITS ON WORKER DOSES

As discussed in Section 4, some worker doses will increase as a result of higher allowable contamination limits and some will decrease due to shorter working times associated with decontamination and monitoring activities. It is possible to determine the conditions under which higher allowable contamination limits will result in offsetting changes to the doses (where increases are equal to savings) and where overall dose savings are possible.

6.2 WORKER DOSES DUE TO SPENT FUEL CASK DECONTAMINATION AND MONITORING ACTIONS

6.2.1 DOE-CH/TPO-001

This report^{ix} includes the actions, duration, and doses due to decontamination and monitoring activities. The combined doses reported to workers due to the cask contents and ambient conditions, as analyzed in Sections 4.3.1.2 and 4.3.2 above, are:

Decontamination	0.13×10^{-3} person Sv
Monitoring	<u>0.1×10^{-3} person Sv</u>
Total	0.23×10^{-3} person Sv

6.2.2. CEPN/EDF Report

A report published by CEPN/EDF^{xvi} provides detailed information on worker doses that result from activities related to preparation and shipment of spent fuel casks from EDF power plants. The report indicates the following:

Total dose for all cask dispatch operations categorized as follows:

Preparation:	5.2×10^{-3} person Sv
<u>Monitoring:</u>	<u>1.3×10^{-3} person Sv</u>
Total	6.5×10^{-3} person Sv

The doses related to decontamination and monitoring breakdown as follows:

- Prevention and elimination of contamination (section 3.1.4 of the report):
 1.51×10^{-3} person Sv (29% of total preparation dose)
- Monitoring for contamination includes 422 smears taken over 300 cm^2 areas by two teams, that is double monitoring, and radiation level monitoring. It is stated that 90% of the collective dose is due to contamination monitoring (section 3.2.3 of the report):
 1.17×10^{-3} person Sv

The CEPN/EDF numbers are applicable to well trained and experienced crews (200 casks per year total, shipped from several reactor sites on a routine basis).

6.2.3. Information from U.S. reactor operator^{viii}

This information was collected during on-going operations that involved experienced crews involved in regularly making shipments.

Doses due to decontamination (two casks per shipment) are reported as:

Shipment #1	1.13 x10 ⁻³ person Sv	0.57 x10 ⁻³ person Sv per cask
Shipment #2	0.85 x10 ⁻³ person Sv	0.43 x10 ⁻³ person Sv per cask
<u>Shipment #3</u>	<u>0.99 x10⁻³ person Sv</u>	<u>0.5 x10⁻³ person Sv per cask</u>
Average total	0.99 x10 ⁻³ person Sv	0.5 x10 ⁻³ person Sv per cask

Doses due to health physics (HP) support are also reported. Based on discussions with operations personnel at the U.S. light water power reactor, it is estimated that 20-30% of the dose reported under HP support are due to decontamination monitoring. This is lower than with the CEPN/EDF data since the reported U.S. operations involve taking most of the contamination smears as the cask is being decontaminated and is reported under "decontamination" doses. The HP support contamination smears are more confirmatory in nature. If it is assumed that 25% of the monitoring/HP support dose is due to contamination monitoring, the doses due to contamination monitoring are:

Shipment #1	1.8 x10 ⁻⁴ person Sv	0.9 x10 ⁻⁴ person Sv per cask
Shipment #2	1.6 x10 ⁻⁴ person Sv	0.8 x10 ⁻⁴ person Sv per cask
<u>Shipment #3</u>	<u>1.0 x10⁻⁴ person Sv</u>	<u>0.5 x10⁻⁴ person Sv per cask</u>
Average	1.5 x10 ⁻⁴ person Sv	0.7 x10 ⁻⁴ person Sv per cask

A comparison of the collective doses is provided below. These collective doses are in person Sv per cask preparation.

Source of information	Decontamination (person Sv)	Monitoring (person Sv)
1. DOE-CH/TPO-001	0.13x10 ⁻³	0.1x10 ⁻³
2. CEPN/EDF report	1.51x10 ⁻³	1.17x10 ⁻³
3. U.S. reactor information	0.5x10 ⁻³	0.07x10 ⁻³

Different reactor facilities and different cask designs will give rise to variations in decontamination and monitoring doses. Discussions with other US utilities indicate typical decontamination exposures range from 0.4x10⁻³ to 1x10⁻³ person Sv per cask loading operation.

The decontamination doses given by the CEPN/EDF report and U.S. reactor are 11 and 4 times higher, respectively, than DOE-CH/TPO-001, and it appears that the DOE report underestimates the durations and locations used in performing these tasks. In order to take into account the most recent operational data available and to reflect international practices, **an average of all three values is used to reflect current decontamination doses (0.71x10⁻³ person Sv)**. The monitoring doses reported by DOE-CH/TPO-001 and the U.S. reactor are within a factor of 2 of each other and are much lower than the CEPN/EDF values, probably due to the redundant monitoring that is performed in France. In order to be representative of known spent fuel operations, **an average of all three values is used to reflect current**

monitoring doses (0.45×10^{-3} person Sv). This gives a **collective dose for decontamination and monitoring activities of 1.2×10^{-3} person Sv.**

6.3. POTENTIAL DOSE REDUCTIONS DUE TO HIGHER ALLOWABLE CONTAMINATION LIMITS

Informal communications with reactor operators have shown that there is no readily available published information on the level of contamination on casks when they are first removed from the spent fuel pools and air-dried. Reported values ranged from 30 to 400 Bq/cm². This indicates that most decontamination and monitoring activities could be eliminated if the allowable contamination limits were on the order of 400 Bq cm⁻². Some monitoring activities would still be needed to ensure that no 'hot spots' were present and to provide assurance of regulatory compliance.

For the purpose of examining the effects that higher contamination limits would have on doses, three cases are examined:

Contamination limits

4 Bq/cm ² beta/gamma	Current limits
40 Bq/cm ² beta/gamma	A factor of 10 higher
400 Bq/cm ² beta/gamma	A factor of 100 higher

As shown in Section 4.5, Table 9, the increases in individual and collective worker doses due to higher contamination limits can be calculated. These increases would be:

Type of worker dose	Contamination limit	Dose	Dose increase
Individual	4	7.5×10^{-7} Sv	0
	40	7.5×10^{-6} Sv	6.8×10^{-6} Sv
	400	7.5×10^{-5} Sv	7.4×10^{-5} Sv
Collective	4	1.7×10^{-6} person Sv	0
	40	1.7×10^{-5} person Sv	1.5×10^{-5} person Sv
	400	1.7×10^{-4} person Sv	1.7×10^{-4} person Sv

If the doses to decontamination and monitoring workers decrease by an amount equal to the increase in doses due to the higher contamination limits, worker collective dose will remain unchanged. If the doses to decontamination and monitoring workers decrease by a greater amount, there will be a collective worker dose savings from increasing the allowable contamination limits. The required decrease in decontamination and monitoring worker dose (dose reduction factor or DRF) can be calculated as follows:

$$DRF = \frac{WCDC}{DMWCD}$$

where:

WCDC = worker collective dose increase due to higher levels of removable surface contamination

DMWCD = decontamination and monitoring worker collective dose

Based on the collective dose for decontamination and monitoring activities of 1.2×10^{-3} person Sv derived in Section 6.2, the required DRFs to offset the increases due to higher contamination limits is as follows:

Contamination limit	Increase in doses due to higher contamination limits	Required dose reduction factor - DRF
40	1.5×10^{-5}	0.013 (1.3%)
400	1.7×10^{-4}	0.14 (14%)

Consequently, a 1.3% reduction in the doses to decontamination and monitoring workers would offset an increase in dose to workers due to raising the allowable contamination limits to 40 Bq/cm². Similarly, a 13% reduction in the doses to decontamination and monitoring workers would offset an increase in dose to workers due to raising the allowable contamination limits to 400 Bq/cm². Greater reductions in doses to the decontamination and monitoring workers would result in lower collective worker doses.

The CEPN/EDF report^{xvi} provides some insight into dose reductions that could be possible with higher allowable contamination limits. In Section 4 of that report, it states that "...savings could reach more than 11% of the total collective dose if double monitoring was discontinued for every monitoring zone of the cask." The average reported total collective dose for cask preparation and monitoring was 6.5×10^{-3} person Sv. Eliminating the need for double monitoring could therefore save 7.2×10^{-4} person Sv per cask shipment. Based on the reported collective dose for decontamination and monitoring activities of 2.68×10^{-3} person Sv this would result in a dose reduction of 0.27 or 27%, easily exceeding the dose reduction factor of 13% required to offset the increased worker collective dose resulting from an allowable contamination limit of 400 Bq cm⁻¹.

6.4 OVERALL DOSE IMPACTS DUE TO HIGHER CONTAMINATION LIMITS

Using the values calculated in Sections 5.3 and 6.3, the overall increases in collective and individual doses due to higher allowable contamination limits would be:

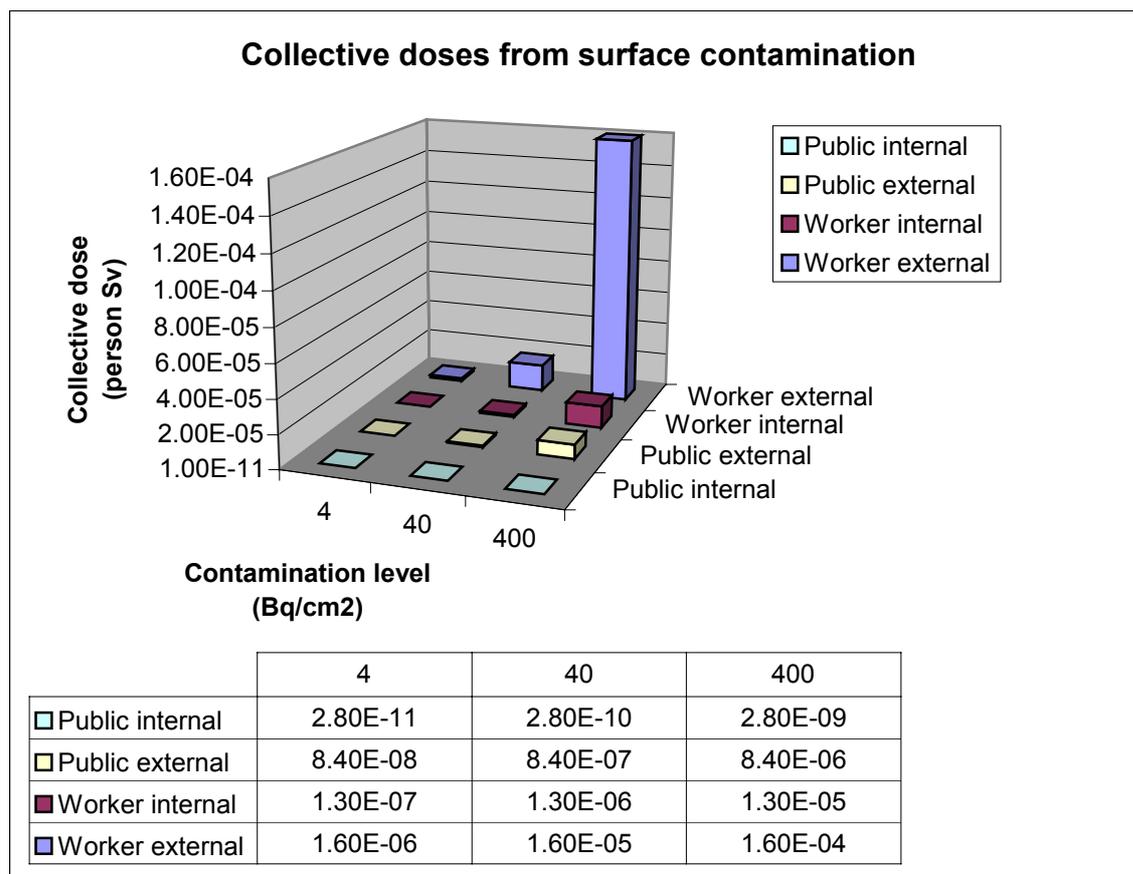
Exposure Group	Contamination Value (Bq cm⁻²)	Increase in Collective Dose (Sv) (internal + external)	Increase in Maximum Exposed Individual Dose (Sv) (internal + external)
Workers	4	0	0
	40	1.5×10^{-5}	6.8×10^{-6}
	400	1.7×10^{-4}	7.4×10^{-5}
Public	4	0	0
	40	7.6×10^{-7}	9.0×10^{-8}
	400	8.3×10^{-6}	9.9×10^{-7}

The increase in collective dose due to higher levels of removable contamination is dominated by the increase in worker doses. The collective worker dose increases are approximately 20 times higher than the collective dose increases for the public. Consequently, optimizing the worker doses will result in optimizing the collective dose due to removable surface contamination on spent fuel casks at levels up to 400 Bq cm⁻².

Adding the increased collective public dose to that of the workers does not have a significant effect on the DRFs required to realize dose savings. There is no change in the DRF for 40 Bq cm⁻² (rounded to two significant figures) and the DRF for 400 Bq cm⁻² increases from 0.013 to 0.014 (one percent increase). The relative insensitivity of the DRF to the public dose is due to the dominance of the worker dose (approximately 20 times higher).

Figure 1 illustrates the relative magnitude of the collective doses calculated for workers and the public from both internal and external exposures at contamination levels of 4, 40, and 400 Bq cm⁻².

Figure 1. Collective dose – all groups



When combined with the worker doses received during decontamination and monitoring activities (1.2×10^{-3} person Sv), worker doses from surface contamination on the cask (both internal and external pathways) constitute 0.14, 1.4, and 12% of the total worker collective dose at contamination levels of 4, 40, and 400 Bq cm⁻², respectively. The collective dose due to decontamination and monitoring activities dominates all the dose pathways considered in this study.

While consideration of collective dose is necessary to evaluate options for optimizing doses, it is also necessary to consider doses to the maximum exposed individual. Worker and public individual doses remain low even at the higher contamination levels.

6.5 CONSERVATISMS AND SENSITIVITIES IN THE MODEL

Discussions with reactor operators indicate that the worker exposure scenarios in the models for inhalation, hand and face contamination and ingestion are very conservative. Radiological control practices such as protective clothing (sometimes including double layers), work habits (influenced by extensive training) and monitoring practices (during work and when exiting radiological areas) reduce incidents of personnel contamination to very few. Consequently, assumptions such as "all workers that touch the cask have skin and face contamination and ingestion" are conservative and result in high estimates of the collective doses to these workers. This results in conservative estimates of the increase in worker collective dose that would occur with higher allowable contamination limits.

Conservative estimates of the increase in worker doses due to higher allowable removable contamination, combined with realistic estimates of the doses received during monitoring and decontamination activities result in very conservative estimates of the DRFs. The actual DRFs that would be needed to produce an overall dose savings to workers are likely to be much lower than those calculated in this report.

Some parameters were chosen to be representative of spent fuel shipment conditions in the United States, such as a high transport vehicle speed (shipments are required to maximize their use of the interstate highway system), a long distance route, low overall population density and long shipment duration. The outcome of the model used in this study is relatively insensitive to these parameters since the public dose (collective and individual) during the shipment is low. The highest individual public dose is during stops where an individual is assumed to be in relatively close proximity to the cask for a short period of time. Similarly, approximately 40% of the collective public dose is attributable to stops.

7. CONCLUSIONS

Doses from removable contamination on spent fuel casks are dominated by the doses received by workers preparing the cask for transport. The greatest component of the worker dose is due to decontamination and monitoring work performed in the vicinity of the loaded cask where the dose rate is relatively high. Based on the three sources of operational information used in this study, the collective dose due to decontamination and monitoring activities (1.2×10^{-3} person Sv per cask turnaround at a level of 4 Bq cm^{-2}) is much higher than the dose received by workers from the removable contamination (1.7×10^{-6} person Sv per cask turnaround at a level of 4 Bq cm^{-2}) by way of inhalation, ingestion, and direct, hand and face irradiation. The relative magnitudes of these doses are reflected in the low DRFs that would be required to realize lower total collective dose due to removable contamination.

Appendix A - Summary of Selected Previous Contamination Studies

Summary of NUREG/CR-1858

The US Nuclear Regulatory Commission (NRC) sponsored a study at Pacific Northwest Laboratory (PNL) of removable surface contamination on radioactive material transportation containers⁴. The study, NUREG/CR-1858, published in 1981, addresses various categories of radioactive material including the consideration of the dose to workers and the public associated with the transport of spent fuels. Estimates of the additional economic costs incurred by lowering the current limits by factors of 10 and 100 were presented.

The modeling effort in NUREG/CR-1858 specifies a generic model that is applied across the various transport containers considered in that study. The potential significant radiation exposure pathways considered are

- Ingestion (intakes of non-fixed contamination transferred to hands)
- Inhalation (intakes of airborne contamination resuspended from container surfaces, and worker's contaminated hands)
- Direct exposure (to container surface contamination, skin contamination, and during decontamination of container surfaces).

The dosimetric evaluations are based on the pre ICRP Publication 30 models and thus are more than twenty years out of date. An interesting aspect of the study is the significance attributed to the ingestion pathway. The exposure scenario involves a transfer of non-fixed contamination from the package surfaces to the hands, foodstuffs, and other items, which enter the mouth. The direct exposure model did not address exposures to the contents of the containers. The model did consider both workers and members of the public.

In applying the model to spent fuel casks it was noted that such containers are in exclusive use and hence not recycled for other uses which potential might lead to contamination entering other pathways leading to members of the public. Transportation workers were assumed to ingest surface contamination from $5 \times 10^{-5} \text{ m}^2$ for each container. No release of the surface contamination was considered during the actual transport and thus the model does not consider inhalation intake by members of the public. The assumed lack of release from the container also means that members of the public were not directly exposed to non-fixed contamination (only direct exposure to the contents of the container). However, despite stating the assumption of no exposure to the public, an

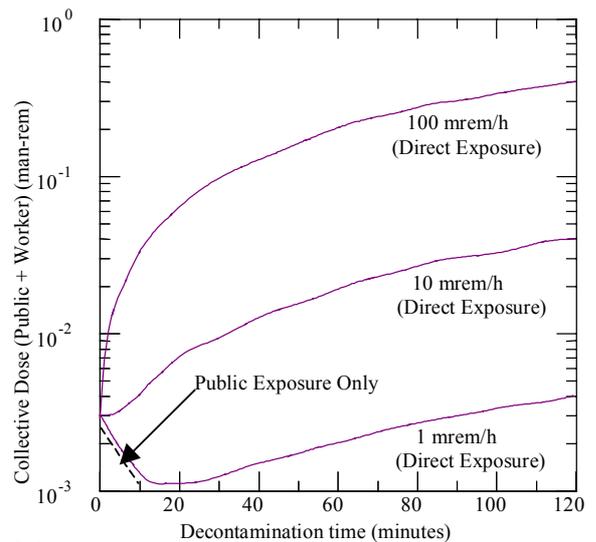


Fig. A.2. Collective dose vs. decontamination time for spent fuel container. Adapted from Ref.

ingestion intake via 10 individuals was assumed as the only source of public exposure to non-fixed surface contamination.

The impact on the collective radiation dose of decontamination activities was evaluated. The analysis considers the total time spent decontaminating at a fixed rate of decontamination, the exposure rate of the worker to the contents of the cask and to the non-fixed contamination, and the reduction in the public dose resulting from the reduced surface contamination. The relative impact of these factors is shown in Fig. A.1 adapted from the study. A surface contamination level of $10^{-4} \mu\text{Ci}/\text{cm}^2$ ($4 \text{ Bq}/\text{cm}^2$) was assumed and that uniform decontamination factor of 10 was achieved for each 30 minutes of effort. That figure indicates an optimum decontamination time and total dose occurs for a direct exposure rate of 1 mrem/h ($10 \mu\text{Sv}/\text{h}$) and as such dose savings from decontamination are only possible when there is a low direct exposure rate. This reflects the finding that it is the worker direct exposure considerations that were driving this model.

Summary of NRPB Report

The United Kingdom National Radiation Protection Board (NRPB) conducted a study⁵ for the UK Department of Transport to establish limits for non-fixed contamination on the surface of transport packages. This effort included formulation of an assessment model to translate the appropriate dose limits to derived limits on surface contamination. The study was reported in 1987.

The exposure pathways for workers consider by the NRPB included

- External irradiation of the skin,
- Inhalation of resuspended surface contamination
- Ingestion of surface contamination transferred to the hands.

The model only addresses the exposure to workers and, while suggesting that the only significant pathway should be inhalation of dispersed contamination during transport, it is noted that such exposures are “exceedingly low.” Thus the model includes no provisions to assessing the exposure to members of the public. The focus of the NRPB report is on deriving contamination limits and thus does not address health risk or a balancing of worker and public exposure.

Derived limits were reported for 49 radioisotopes under various parameter assumptions. Of these nuclides, only ^{134}Cs and ^{137}Cs were included that would be appropriate for SNF. Derived limit results of 600 and 700 Bq/cm^2 were reported for ^{137}Cs and ^{134}Cs , assuming average distance and time parameter values (“choice estimate” terminology used in the report). Values for ^{60}Co were not reported, but the results for Cs indicate an increase in the derived limits of about a factor of 100 are possible for typical SNF applications.

Summary

The NUREG and NRPB reports are thus somewhat contradictory in their assessment of the relevant exposure scenarios. The somewhat arbitrary selection of

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parameter values in the models appears to lead to conservative assignments as appropriate in the stated application. However, a model suitable for balancing health risk in the occupational and public exposures as resulting from the level of decontamination requires use of a more detailed and complete modeling effort. To its credit the NRPB modeling effort did attempt to set forth the uncertainties in model parameters. Parameter and model uncertainties should be addressed in the formulating any future models for setting surface contamination levels.

Appendix B - Worker Parameters From DOE-TPO/CH-001

Step No.	Description	Area		Staff		Activity		Work		Dose		
		Dose		Total	Number	Time (min)		Distance	Rate for		(person-mrem)	
		Rate (mrem/h)	Type	In Area	Doing Cask Work	In Area	Near Cask	From Cask in Feet	Cask Work (mrem/hr)	Cask Work	Area	Total
1	Receive transport vehicle and empty cask-monitor inspect.											
	Unhook over-the-road carrier's drive unit-attach utility drive unit.											
1.1	Vehicle arrives and is spotted at fixed monitoring location at outer inspection gate. Check documentation.	0	TD	2	0	5	0	20	0	0.000	0.000	0.000
		0	SG	1	0	5	0	30	0	0.000	0.000	0.000
		0	RM	1	0	5	0	30	0	0.000	0.000	0.000
		0	QC	1	0	5	0	30	0	0.000	0.000	0.000
		0	SG	1	0	5	0	30	0	0.000	0.000	0.000
1.2	Monitor transport vehicle, perform security search, perform visual inspection and disconnect carrier drive unit from transport vehicle.	0	RM	1	1	20	5	5	0.1	0.008	0.000	0.008
		0	SG	1	1	20	5	5	0.1	0.008	0.000	0.008
		0	TD	2	0	20	10	10	0	0.000	0.000	0.000
1.3	Connect utility drive unit to transport vehicle.	0	YD	1	0	10	10	10	0	0.000	0.000	0.000
										0.017	0.000	0.017

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4.1	Move from washdown area to loading area.	0.5	YD	2	0	10	0	20	0	0.000	0.167	0.167	0.167
										0.000	0.167	0.167	0.167
5	Prepare cask for removal from transport vehicle-remove impact limiters and tiedowns.												
5.1	Obtain and replace power and hand tools.	0.5	M-C	2	0	10	0	20	0	0.000	0.167	0.167	0.167
5.2	Area radiation survey.	0.5	RM	1	1	15	10	3	0.2	0.033	0.125	0.158	
5.3	Crane retrieves hooks and grapples for impact limiters.	0.5	CO	1	0	10	0	20	0	0.000	0.083	0.083	0.083
		0.5	M-C	1	0	10	0	20	0	0.000	0.083	0.083	0.083
5.4	Impact limiter removal.												
	Remove impact limiter bolts, clamps, etc.	0.5	M-C	2	2	10	10	3	0.2	0.067	0.167	0.233	
		0.5	OP	1	1	10	10	5	0.1	0.017	0.083	0.100	
	Store impact limiter fasteners.	0.5	M-C	2	0	10	0	10	0	0.000	0.167	0.167	0.167
	Remove impact limiters with crane and place in setdown area (two trips required-time to complete both trips) seal bolt holes.	0.5	CO	1	0	15	0	20	0	0.000	0.125	0.125	0.125
		0.5	M-C	2	2	20	10	3	0.2	0.067	0.333	0.400	
		0.5	M-C	1	1	20	10	5	0.1	0.017	0.167	0.183	
		0.5	M-C	1	1	25	10	5	0.1	0.017	0.167	0.183	

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5.5	Tiedown removal. Remove tiedowns, store tiedowns.	0.5	M-C	2	2	30	20	3	0.2	0.133	0.500	0.633
		0.5	OP	1	1	30	20	5	0.1	0.033	0.250	0.283
		0.5	M-C	2	0	10	0	20	0	0.000	0.167	0.167
5.6	Disconnect cask monitoring equipment.	0.5	M-C	2	2	10	5	3	0.2	0.033	0.167	0.200
		0.5	OP	1	1	10	5	3	0.2	0.017	0.083	0.100
5.7	Apply lubricant to trunnions.	0.5	M-C	1	1	5	5	3	0.2	0.017	0.042	0.058
6	Remove cask from vehicle and place on cask service pad.									0.450	2.875	3.323
6.1	Pick up yoke, check operation, and carry to cask.	0.5	CO	1	0	45	0	30	0	0.000	0.375	0.375
		0.5	OP	1	0	45	0	30	0	0.000	0.375	0.375
6.2	Attach yoke.	0.5	CO	1	0	5	0	20	0	0.000	0.042	0.042
		0.5	OP	1	1	5	5	5	0.1	0.008	0.042	0.050
6.3	Upend cask and lift off supports.	0.5	CO	1	0	20	0	20	0	0.000	0.167	0.167
		0.5	OP	1	1	20	10	8	0.1	0.017	0.167	0.183
6.4	BWR extra yoke and adjustment.	0.5	CO	1	0	30	0	0	0	0.000	0.250	0.250
		0.5	OP	1	1	30	20	5	0.1	0.033	0.250	0.283
6.5	Carry cask to pad.	0.5	CO	1	0	15	0	20	0	0.000	0.125	0.125
		0.5	OP	1	1	15	10	10	0	0.000	0.125	0.125
6.6	Lower cask to pad and remove yoke.	0.5	CO	1	0	5	0	20	0	0.000	0.042	0.042
		2	OP	1	1	5	5	5	0.1	0.008	0.167	0.175

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6.7	Install work platform.	2	CO	1	0	15	0	38	0	0.000	0.500	0.500
		2	OP	2	2	15	10	0	0.1	0.033	1.000	1.033
7	Remove transport vehicle from loading area.						PWR			0.067	3.125	3.191
							BWR			0.100	3.625	3.724
7.1	Move vehicle out of loading area to external parking area.	5	YD	1	0	29	0	N/A	0	0.000	0.167	0.167
8	Prepare cask for placement in loading pit-remove outer lid-looser inner lid.									0.000	0.167	0.167
8.1	Remove outer lid bolts and store.	2	M-C	2	2	10	10	3	0.2	0.067	0.667	0.733
		2	OP	1	1	10	10	5	0.1	0.017	0.333	0.350
8.2	Remove outer lid and store.	2	CO	1	0	10	10	10	0	0.000	0.333	0.333
		2	M-C	1	1	10	10	3	0.2	0.033	0.333	0.367
		2	OP	1	1	10	10	6	0.1	0.017	0.333	0.350
8.3	Seal bolt and pin holes.	2	M-C	1	1	10	10	3	0.2	0.033	0.333	0.367
		2	OP	1	1	10	10	3	0.2	0.033	0.333	0.367
8.4	Radiation survey of inner lid.	2	RM	1	1	5	5	3	0.2	0.017	0.167	0.183
8.5	Measure cask cavity pressure.	2	OP	1	1	10	10	3	0.2	0.033	0.333	0.367
8.6	Sample cask cavity gasses.	2	OP	1	1	10	10	3	0.2	0.033	0.333	0.367

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8.7	Vent cask.	2	OP	1	1	5	5	3	0.2	0.017	0.167	0.183
8.8	Fill cask with water.	2	OP	1	1	30	5	3	0.2	0.017	1.000	1.017
8.9	Sample water in cask.	2	OP	1	0	10	0	20	0	0.000	0.333	0.333
	Loosen inner lid bolts.	2	M-C	2	2	20	20	3	0.2	0.133	1.333	1.467
		2	RM	1	1	20	20	3	0.2	0.067	0.667	0.733
		2	OP	1	1	20	20	5	0.1	0.033	0.667	0.700
8.11	Remove and store inner lid bolts.	2	M-C	2	2	10	10	3	0.2	0.067	0.667	0.733
		2	OP	1	1	10	10	5	0.1	0.017	0.333	0.350
8.12	Apply lubricant in trunnions.	2	M-C	1	1	5	5	3	0.2	0.017	0.167	0.183
8.13	Remove work platform.	1	CO	1	0	10	10	20	0	0.000	0.167	0.167
		1	OP	2	2	10	10	8	0.1	0.033	0.333	0.367
9	Move cask to loading pit-- remove inner lid bolts--place cask in loading pit.									0.683	9.333	10.017
9.1	Bring yoke to cask and attach.	2	CO	1	0	5	0	20	0	0.000	0.167	0.167
		2	OP	1	1	5	5	3	0.2	0.017	0.167	0.183
9.2	Life, cask, move to loading pit, lower into water, pause for bolt removal, and lower to bottom of pit.	2	CO	1	0	30	0	20	0	0.000	1.000	1.000
		4	M-C	1	1	10	10	3	0.2	0.033	0.667	0.700
		4	RM	1	1	10	10	3	0.2	0.033	0.667	0.700
		3	OP	1	1	30	20	3	0.2	0.067	1.500	1.567

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	4	QC	1	0	0	75	0	Not Applicable	0	0.000	5.000	5.000
11.2	4	OP	2	0	0	30	0	20	0	0.000	4.000	4.000
Move SFAS to loading area and place in cask.												
	4	OP	2	0	0	75	0	20	0	0.000	10.000	10.000
12										0.000	10.000	10.000
Install fuel spacers and inner lid on the shipping cask.										0.000	25.000	25.000
12.1	4	CO	1	0	5	5	0	20	0	0.000	0.333	0.333
Pick up yoke and lid.												
	4	OP	1	1	5	5	5	3	0.2	0.017	0.333	0.350
12.2	4	CO	1	0	15	15	0	20	0	0.000	1.000	1.000
Lower lid into position and install yoke.												
	4	OP	1	0	15	15	0	20	0	0.000	1.000	1.000
	4	QC	1	0	15	15	0	20	0	0.000	1.000	1.000
										0.017	3.667	3.683
13												
Lift cask from loading pit--install four inner lid bolts--place cask on service pad.												
13.1	4	CO	1	0	10	10	10	20	0	0.000	0.667	0.667
Lift cask to water surface.												
	4	RM	1	1	10	10	5	5	2	0.167	0.667	0.833
	4	OP	1	1	10	10	2	10	0	0.000	0.667	0.667
13.2	4	M-C	1	1	5	5	5	3	10	0.833	0.333	1.167
Install four lid bolts.												
	4	OP	1	1	5	5	5	5	2	0.167	0.333	0.500
13.3	4	CO	1	1	15	15	10	20	0	0.000	1.000	1.000
Lift cask out of water and allow to drip dry (wash cask during lift).												
	4	OP	1	1	15	15	10	5	0	0.000	1.000	1.000

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		4	RM	1	1	15	10	5	0	0.000	1.000	1.000
13.4	Move cask to service pad.	2	CO	1	1	10	10	20	0	0.000	0.333	0.333
		2	OP	1	1	10	10	10	0	0.000	0.333	0.333
13.5	Place cask on service pad.	2	CO	1	1	5	5	20	0	0.000	0.167	0.167
		2	OP	1	1	5	5	10	0	0.000	0.167	0.167
13.6	Disengage yoke and install work platform.	2	CO	1	1	10	10	20	0	0.000	0.333	0.333
		2	OP	2	2	10	10	10	0	0.000	0.667	0.667
14	Decontaminate cask exterior.									1.167	7.667	8.833
14.1	Survey cask surface.	2	RM	1	1	20	15	5	1	0.250	0.667	0.917
14.2	Decontaminate cask.	2	OP	2	2	25	45	3	2	3.000	1.667	4.667
15	Prepare cask for shipment--install lids--flush, drain and dry cask--seal cask									3.250	2.333	5.583
15.1	Install inner lid bolts.	2	M-C	3	3	15	15	3	20	15.000	1.500	16.500
		2	OP	1	1	15	10	3	3	0.500	0.500	1.000
		2	QC	1	1	15	10	3	3	0.500	0.500	1.000
15.2	Decontaminate area between lids.	2	OP	2	2	5	5	3	20	3.333	0.333	3.667
15.3	Install instrumentation.	2	OP	2	1	30	10	3	3	0.500	2.000	2.500

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15.4	Flush and drain cask.	2	OP	2	1	30	3	1	200	10,000	2,000	12,000
15.5	Dry cask cavity.	2	OP	2	1	10	3	3	200	10,000	0.667	10.667
				0	0	60	0	NA	0	0.000	0.000	0.000
				0	0							
15.6	Leak test cask inner lid seal.	2	OP	2	1	10	3	3	200	10,000	0.667	10.667
		2	QC	1	1	10	10	5	10	1.667	0.333	2.000
15.7	Fill cask with inert gas.	2	OP	1	1	10	5	30	1	0.083	0.333	0.417
15.8	Plug and lockwire cavity openings.	2	M-C	2	2	5	5	3	200	33.333	0.333	33.667
		2	OP	1	1	5	5	5	30	2.500	0.167	2.667
15.9	Inspect outer lid, gaskets, etc.	2	M-C	2	2	30	30	30	1	1.000	2.000	3.000
15.10	Install outer lid.	2	CO	1	1	10	10	20	2	0.333	0.333	0.667
		2	M-C	2	2	20	10	3	30	10.000	1.333	11.333
		2	OP	1	1	20	15	5	10	2.500	0.667	3.167
15.11	Install water absorbent material around cask lid.	2	OP	2	2	5	5	3	10	1.667	0.333	2.000
										102.917	14.000	116.917
16	Move cask to vehicle loading area.											
16.1	Move yoke to cask.	2	CO	1	1	10	10	20	2	0.333	0.333	0.667
16.2	Remove work platform.	2	CO	1	1	10	10	20	2	0.333	0.333	0.667
		2	OP	2	2	10	10	5	10	3.333	0.667	4.000

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16.3	Attach yoke to cask.	2	CO	1	1	10	10	20	2	0.333	0.333	0.667
		2	OP	1	1	10	2	10	8	0.267	0.333	0.600
16.4	Lift cask and travel to loading area.	2	CO	1	1	15	15	30	1	0.250	0.500	0.750
		2	OP	1	1	15	5	10	8	0.667	0.500	1.167
17	Move transport vehicle to loading area.									5.517	3.000	8.517
17.1	Move vehicle into loading area.	0.5	YD	1	0	20	0	50	0	0.000	0.167	0.167
18	Place the cask on the transport vehicle.									0.000	0.167	0.167
18.1	Lower cask into position on vehicle.	0.5	CO	1	1	15	15	20	2	0.500	0.125	0.625
		0.5	OP	1	1	10	5	3	20	1.667	0.083	1.750
18.2	BWR extra yoke adjustment.	0.5	CO	1	1	30	30	20	2	1.000	0.250	1.250
		0.5	OP	1	1	30	30	10	8	4.000	0.250	4.250
18.3	Remove absorbent material from cask top.	0.5	OP	1	1	5	5	3	10	0.833	0.042	0.875
18.4	Disconnect, remove yoke, and store.	0.5	CO	1	1	10	5	20	2	0.167	0.083	0.250
		0.5	OP	1	1	10	2	3	20	0.667	0.083	0.750
19	Contamination survey--decontaminate cask exterior.						PWR			3.833	0.417	4.250
							BWR			8.833	0.917	9.750

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19.1	Radiation survey of cask and vehicle.	0.5	RM	1	1	40	30	5	15	7.500	0.333	7.833
		0.5	OP	1	1	25	25	10	8	3.333	0.208	3.542
19.2	Spot decontamination.	0.5	OP	1	1	10	10	3	30	5.000	0.083	5.083
										15.833	0.625	16.458
20	Prepare loaded vehicle for shipment-install cask tiedowns, impact limiters and personnel barrier.											
20.1	Pick up and store yokes and hooks.	0.5	CO	1	0	30	20	20	2	0.000	0.250	0.250
		0.5	OP	1	1	30	20	20	2	0.667	0.250	0.917
20.2	Install cask tiedowns.	0.5	M-C	2	2	30	20	3	30	20.000	0.500	20.500
		0.5	OP	1	1	30	20	5	5	1.667	0.250	1.917
20.3	Install impact limiters.	0.5	M-C	2	2	30	20	3	20	13.333	0.500	13.833
		0.5	CO	1	1	20	20	20	2	0.667	0.167	0.833
		0.5	OP	1	1	30	30	5	5	2.500	0.250	2.750
20.4	Install monitoring equipment.	0.5	M-C	2	2	30	5	3	10	1.667	0.500	2.167
		0.5	OP	1	1	30	5	5	5	0.417	0.250	0.667
20.5	Install personnel barrier and security seals.	0.5	M-C	2	2	10	10	3	20	6.667	0.167	6.833
		0.5	OP	1	1	10	10	5	5	0.833	0.083	0.917
										48.417	3.167	51.583
21	Final inspection and contam-											

Appendix C

Modeling Public Exposure to Resuspended Surface Contamination During Movement

During movement, removable contamination resuspended from the package surface will disperse into the environment. The airborne activity concentration resulting from this resuspension depends primarily on the rate of release, Q , and the speed of the transport vehicle, v . The activity concentration can be estimated using the Gaussian plume model. The activity concentration distribution per unit release rate at location (x, y) from a ground-level point source is given by

$$\chi/Q(x, y) = \frac{1}{\pi v \sigma_y \sigma_z} e^{-\frac{1}{2} \left(\frac{y}{\sigma_y} \right)^2} \tag{C-1}$$

where σ_y and σ_z denote the variance of the Gaussian distribution in the y (cross wind) and z (vertical) direction, respectively (Turner 1967). The values of σ_y and σ_z are functions of the downwind distance x and depend on the “stability” of the atmosphere. The calculations performed here assume a stability class C and utilize the so-called Pasquill-Gifford curves for the variances as a function of downwind distance (Gifford 1961).

Consider a divided, limited access roadway as shown in Fig. C-1.

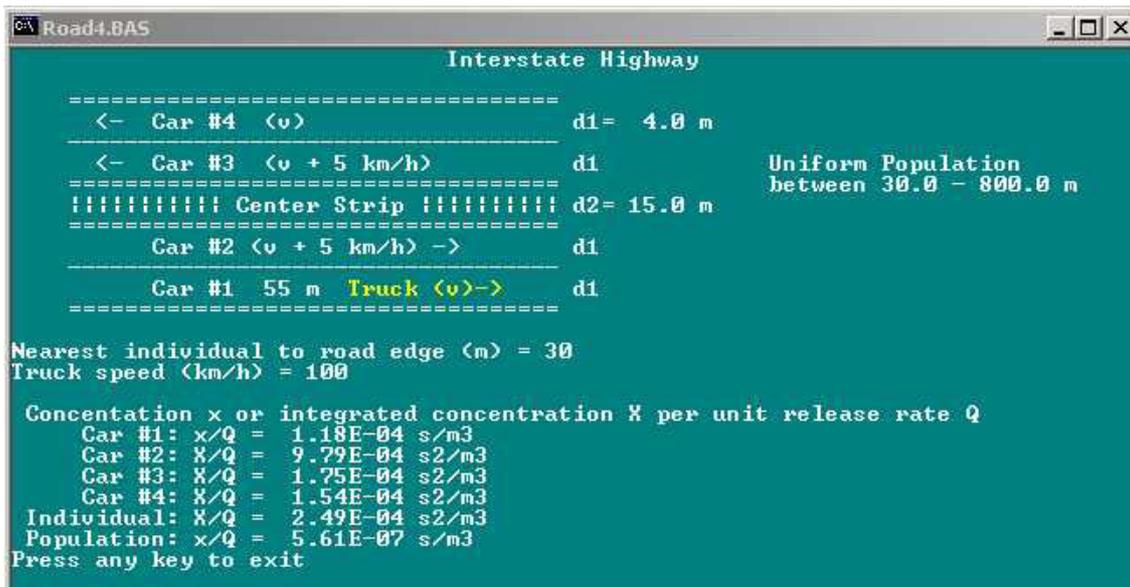


Fig. C-1. Schematic of a divided, limited access highway with the truck (lower lane) proceeding at speed "v". The screen shot shows the calculation of the concentration or time-integrated concentration per unit

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release for various individuals and an assumed uniform population adjacent to the roadway. See the text for further details.

Activity released from the truck will initially be diluted by the turbulence in the wake of the truck. The point source formulation of Eqn (C-1) can be corrected by considering a virtual source displaced by a distance x_0 that corresponds to the dilution due to mixing in the truck's wake (Turner 1967). The activity concentration in the wake per unit release is given by the reciprocal of the product of the cross-sectional area of the truck and its speed. The practice of constraining the wake dilution, in this case to one-third the theoretical value, is followed here (Snell 1981).

Consider an individual located at a distance d from the edge of the road with lanes of width d_l . The closest individual is at a distance $d + 0.5 d_l$ from the centerline of the truck. The integrated airborne concentration per unit release rate Ψ/Q at the location of the individual is

$$\Psi/Q = \int \chi/Q(x_0 + vt, d + 0.5 d_l) dt \quad (C-2)$$

where v is the speed of the truck.

The effective dose E to that individual resulting from inhalation of the dispersing activity is

$$E = Q \frac{\Psi}{Q} \dot{V} e \quad (C-3)$$

where Q is the activity release rate (Bq s^{-1}), Ψ/Q is the integrated airborne concentration per unit release rate ($\text{s}^2 \text{ m}^{-3}$), \dot{V} is the individual's air intake rate ($\text{m}^3 \text{ s}^{-1}$), and e is the effective dose coefficient (Sv Bq^{-1}).

The airborne activity concentration in the car following the truck is given by Eqn (C-1) with x the sum of the displacement of the virtual source x_0 and the separation distance of the vehicles (55 m in Fig. C-1). The effective dose E to an individual in the car resulting from inhalation is thus

$$E = Q \frac{\chi}{Q} \dot{V} e t \quad (C-4)$$

where χ/Q is the airborne concentration per unit release rate (s m^{-3}) and t is time the car follows the truck (s). All other terms are defined above. Similar equations can be written for individuals in cars approaching or passing the truck.

Consider a population of uniform density located between y_1 and y_2 from the edge of the roadway. The airborne concentration averaged over the population is given by

$$\bar{x}/Q = 0.5 \left[\int dt \int_{y_1}^{y_2} \chi/Q(x_0+vt, 0.5 d_1+y) + \int dt \int_{y_1}^{y_2} \chi/Q(x_0+vt, 3.5 d_1+d_2+y) \right] \quad (C-5)$$

where the first term corresponds to the population adjacent to the lane containing the truck and the second term is on the opposite side of the highway; d_2 being the width of the center strip in Fig. C-1.

The collective dose S (man Sv) due to inhalation is

$$S = \rho Q \frac{\bar{x}}{Q} \dot{V} (y_2 - y_1) v e t \quad (C-6)$$

where ρ is the population density (# m⁻²), y_2 and y_1 are the upper and lower bound distances (m) of the population from the roadway, v is the speed of the truck (m s⁻¹), and t is the total travel time (s) in the populated region.

The dispersion data for a two-lane roadway (state highway) is shown in Fig. C-2.

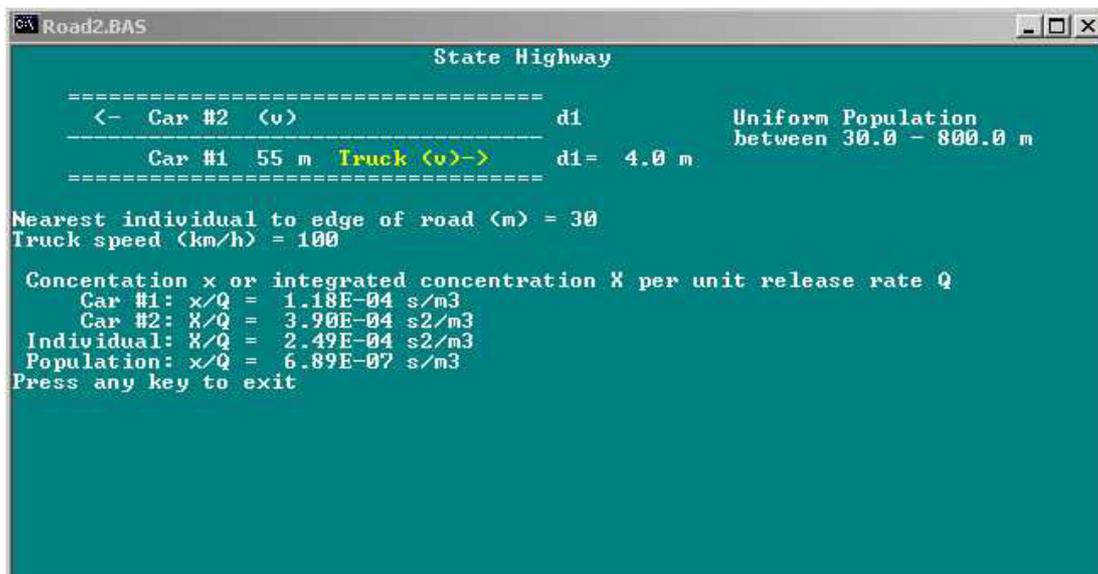


Fig. C-2. . Schematic of a two-lane highway with the truck (lower lane) proceeding at a speed "v". The screen shot shows the calculation of the concentration or time-integrated concentration per unit release for various individuals and an assumed uniform population adjacent to the roadway

Illustrative Examples

A few illustrative example calculations are presented based on Fig. C-1 and the dispersion parameters in the figure. Assume the release rate of ¹³⁷Cs from the truck is 1 Bq s⁻¹. The committed effective dose coefficient for inhalation of ¹³⁷Cs by an adult is

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$4.6 \times 10^{-9} \text{ Sv Bq}^{-1}$ (ICRP 1995) and the air intake rate is $22 \text{ m}^3 \text{ d}^{-1}$ or $2.55 \times 10^{-4} \text{ m}^3 \text{ s}^{-1}$ (ICRP 1994). The dispersion parameters are shown in Fig. C-1.

Car #1. Assuming that the car follows the truck for a period of 3 h ($1.08 \times 10^4 \text{ s}$), then the effective dose is

$$\begin{aligned} E &= Q \frac{\lambda}{Q} \dot{V} e t \\ &= (1.0 \text{ Bq s}^{-1}) (1.18 \times 10^{-4} \text{ s m}^{-3}) (2.55 \times 10^{-4} \text{ m}^3 \text{ s}^{-1}) (4.6 \times 10^{-9} \text{ Sv Bq}^{-1}) (1.08 \times 10^4 \text{ s}) \\ &= 1.5 \times 10^{-12} \text{ Sv} \end{aligned}$$

Car #2. The dose to an individual in car #2 is

$$\begin{aligned} E &= Q \frac{\Psi}{Q} \dot{V} e \\ &= (1.0 \text{ Bq s}^{-1}) (9.79 \times 10^{-4} \text{ s}^2 \text{ m}^{-3}) (2.55 \times 10^{-4} \text{ m}^3 \text{ s}^{-1}) (4.6 \times 10^{-9} \text{ Sv Bq}^{-1}) \\ &= 1.2 \times 10^{-15} \text{ Sv} \end{aligned}$$

Collective dose: Assuming a strip of land (30 to 800 m wide) adjacent to a highway has a population density of 80 km^{-2} ($8.0 \times 10^{-5} \text{ m}^{-2}$). Furthermore the extent of this strip is such that it takes the truck 4 days ($3.46 \times 10^5 \text{ s}$) to traverse the strip. The collective dose is

$$\begin{aligned} S &= \rho Q \frac{\bar{x}}{Q} \dot{V} (y_2 - y_1) v e t \\ &= (8.0 \times 10^{-5} \text{ m}^{-2}) (1 \text{ Bq s}^{-1}) (5.61 \times 10^{-7} \text{ s m}^{-3}) (2.55 \times 10^{-4} \text{ m}^3 \text{ s}^{-1}) (770 \text{ m}) \\ &\quad (27.8 \text{ m s}^{-1}) (4.6 \times 10^{-9} \text{ Sv Bq}^{-1}) (3.46 \times 10^5 \text{ s}) \\ &= 3.9 \times 10^{-13} \text{ person Sv} \end{aligned}$$

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References

Gifford, F. A., Jr. 1961. "Use of routine meteorological observations for estimating atmospheric dispersion," **Nucl. Saf.** 2(4):44-57.

ICRP 1994. International Commission on Radiological Protection, *Human Respiratory Tract Model for Radiological Protection*, ICRP Publication 66 (Pergammon Press, Oxford).

ICRP 1995. International Commission on Radiological Protection, *Age-dependent Doses to Members of the Public from Intakes of Radionuclides, Part 4*, ICRP Publication 71 (Pergammon Press, Oxford).

Snell, W.G., and Juback, R.W 1981. *Technical Basis for Regulatory Guide 1.145*, NUREG/CR-2260, U.S. Nuclear Regulatory Commission, Washington, DC.

Turner, D.B. 1967. *Workbook of Atmospheric Dispersion Estimates*, Public Health Service, Publication 999-AP-26, Cincinnati, Ohio.

Appendix D - Collective Internal Dose to Passengers in Vehicles During Transport

The calculation of collective internal dose to the public in vehicles due to inhalation of resuspended surface radioactivity from fuel casks transported by highway uses of the algorithm discussed in Appendix C, which calculates the time-integrated value of Π/Q for vehicles following, passing and meeting the shipment on a multilane highway (Figure C-1) or other highway (Figure C-2).

The collective internal dose for vehicles following (traffic lane #1) the shipment is estimated using the summation of Π/Q ($s\ m^{-3}$) for the first 100 vehicles behind the transport, corresponding to a distance of 5.5 km for a following distance of 55 m between each vehicle. The value of Π/Q falls rapidly with trailing distance, as shown in Figure D-1, so that the exclusion of vehicles beyond 5.5 km does not affect the estimate appreciably. The resulting summation gives the value:

$$\sum_{i=1}^{100} \left(\frac{x}{Q} \right)_i = 3.31 \times 10^{-4} \text{ s m}^{-3}$$

Using this value with the other factors given in Section 5.1.4.1 gives a collective dose of $4.9H10^{-13}$ person Sv. The total affected population is 100, if there is 1 passenger per vehicle.

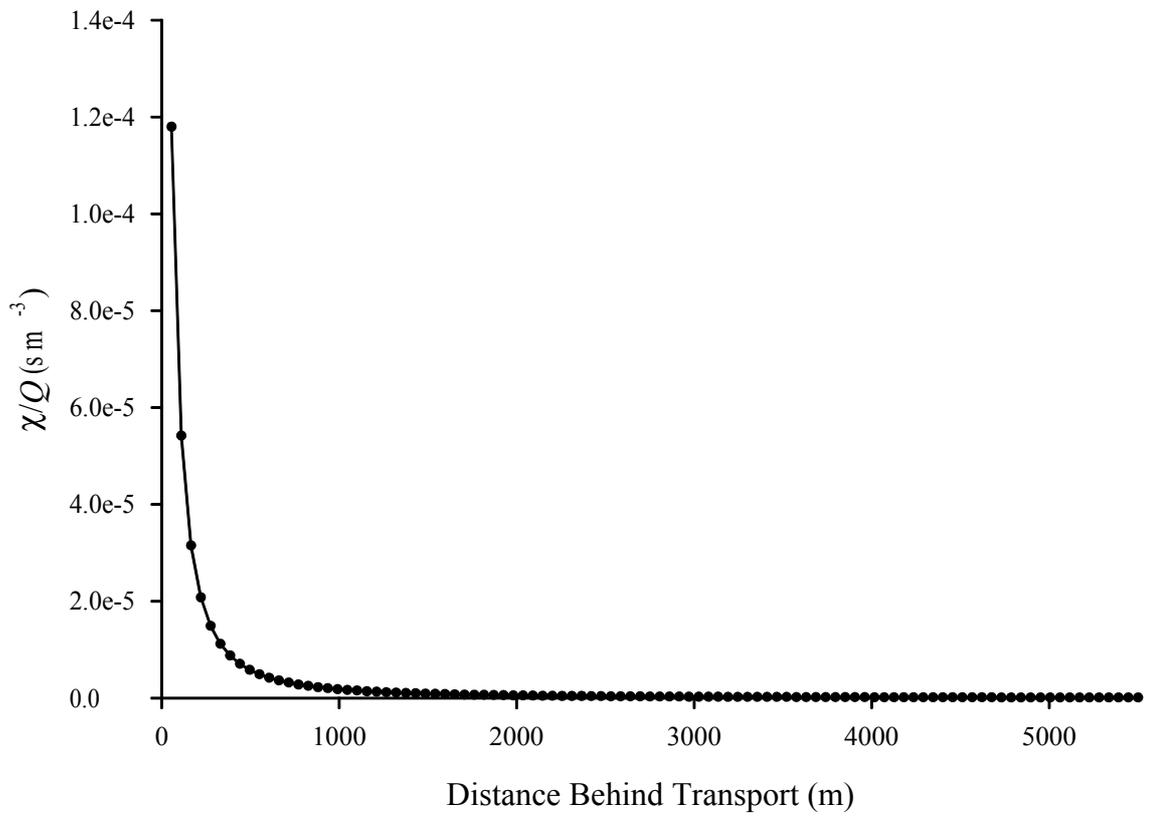
Collective internal doses to passengers in vehicles passing (traffic lane #2) or meeting (traffic lanes #3 and #4) shipments of spent fuel casks are estimated as the product of the number of affected passengers and the integrated values for Π/Q provided in Appendix C. The number of affected passengers is related to the number of vehicles going past the transport, given as the product of the total time *en route* and the relative speed of vehicles in the other lanes to that of the shipment, divided by the following distance of the vehicles going past the transport. The total time *en route* is the ratio of total distance to transport speed on a multi-lane roadway for lanes #2 and #3. The total time for lane #4 takes into account both distance on multi-lane roadways and on other roads (state highways). Estimates of the collective doses using the same factors as in Section 5.1.4.2 (lane #2) and Section 5.1.4.3 (lane #3 and lane #4, multilane highway, and lane #4, other highway) are shown in the table below.

Lane	Persons Affected	<i>E</i> (person Sv)
2	3,968	$3.96H10^{-13}$
3	162,695	$2.90H10^{-12}$
4	165,927	$2.78H10^{-12}$

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Figure D-1

Values of χ/Q for Vehicles
Following a Spent-Fuel Cask Transport



Appendix E - Inhalation Population Dose from Contamination at Stops

The committed effective dose equivalent (CEDE) from inhalation is given¹ by

$$E = C_d f T B_{\text{inh}} R_{10} ,$$

where C_d is the airborne activity concentration (Bq m^{-3}), f is the respirable fraction, T is the exposure time (h), B_{inh} is the respiration rate ($\text{m}^3 \text{h}^{-1}$), and R_{10} is the inhalation dose coefficient (Sv Bq^{-1}). The CEDE due to resuspended activity from a contaminated shipping cask during a stop (such as for food and fuel) is estimated by assuming that the exposed population is uniformly distributed in concentric rings around the transport in the direction of the wind. There are two such rings in our analysis – one adjacent to the shipment and an adjoining one at greater distances – so that the total CEDE is the sum of the proximal dose E_p (from intakes up to 100 m from the cask) and the distal dose E_d (for intakes >100 m from the package)²,

$$E = E_p + E_d .$$

All factors used in calculating CEDE for a population are the same in the two rings except the airborne activity concentration, which diminishes as the contamination diffuses into a larger volume downwind from the source. The number of exposed individuals also changes with distance from the source (because of lateral and vertical dispersion of the contamination) when calculating population dose.

Proximal Dose

The proximal dose to the population is calculated using an average airborne activity concentration for the exposed population from a minimum distance³ a to 100 m from the source. The average airborne concentration is defined as:

¹Section 3.3, “Inhalation”, of IAEA CRP Modeling Group draft report, p. 11.

²Gaussian plume diffusion models may be used, if desired, in estimating airborne concentrations and doses at distances >100 m from the source.

³Minimum distances from 5 m to 75 m are defined by the IAEA CRP Modeling Group for populations exposed during different stop scenarios.

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$$\bar{C}_d = \frac{\int_{r=a}^{100} C_d \, dr}{\int_{r=a}^{100} dr}$$

The airborne activity concentration C_d (Bq m^{-3}) is a function of the distance r downwind from the source and is given by

$$C_d = \frac{R A A_c C}{v Q},$$

when the transport is outside, where⁴ R is the resuspension rate (10^{-4} h^{-1}), A is the surface area of the cask (130 m^2), A_c is the non-fixed areal contamination density (Bq m^{-2}), C is the containment factor ($C = 0.01$ for covered casks and $C = 1$ for uncovered), and v is the average wind speed (2 m s^{-1}). The variable Q represents the effective cross-sectional area of the plume as a function of distance from the cask,

$$Q = 10 f_r A,$$

where f_r takes on the values below⁵ for specific values of r .

r (m)	5	10	30	50
f_r	1.5	2	6	10

To determine values of r for 5 m to 100 m from the cask for the proximal dose, r can be modeled using the information above by noting that

$$f_r = (0.1 r + 1), \text{ for } 5 \text{ m} \leq r < 10 \text{ m},$$

and

$$f_r = 0.2 r, \text{ for } 10 \text{ m} \leq r \leq 50 \text{ m}.$$

Extrapolating f_r from 50 m to 100 m

$$f_r = 0.2 r, \text{ for } 50 \text{ m} < r \leq 100 \text{ m}.$$

The resulting relation of f_r to r over the whole range $5 \text{ m} \leq r < 100 \text{ m}$ is shown graphically in Figure E-1.

Dose to the Maximum Exposed Individual

⁴Parameter values, where given, are from IAEA CRP Modeling Group guidance.

⁵IAEA CRP Modeling Group Draft Report, p. 11.

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The maximum exposed individual is located in the proximal region for all scenarios proposed by the IAEA CRP modeling group for stops during highway or rail transport.⁶ The activity concentration C_d at a specific distance r , and not the average concentration, is used in determining dose to the maximally exposed individual. Dose to the maximum exposed individual is given by

$$E_{\max} = C_d f T B_{\text{inh}} R_{10} = \frac{R A A_c C}{v Q} f T B_{\text{inh}} R_{10} = \frac{R A_c C}{10 v f_r} f T B_{\text{inh}} R_{10}.$$

Population Dose

An average airborne concentration for evaluating doses to a population from a distance $a \ni 5$ m to 100 m from the transport⁷ is calculated using

$$\bar{C}_d = \frac{\int_{r=a}^{100} C_d dr}{\int_{r=a}^{100} dr} = \frac{R A A_c C}{10 A v} \frac{\int_{r=a}^{100} \frac{dr}{f_r}}{\int_{r=a}^{100} dr} = \frac{R A_c C}{10 v} \frac{\int_{r=a}^{100} \frac{dr}{f_r}}{\int_{r=a}^{100} dr}.$$

To account for the case where the closest exposed individual is less than 10 m from the transport, *i.e.* for 5 m $\# a < 10$ m (since $a \ni 5$), the expression for average airborne concentration becomes

$$\begin{aligned} \bar{C}_{d,5-100} &= \frac{R A_c C}{10 v} \frac{\left[\int_{r=a}^{10} \frac{dr}{1 + 0.1r} + \int_{r=10}^{100} \frac{dr}{0.2r} \right]}{\int_{r=a}^{100} dr} = \frac{R A_c C}{10 v} \frac{10 \ln(1 + 0.1r) \Big|_{r=a}^{10} + 5 \ln r \Big|_{r=10}^{100}}{\int_{r=a}^{100} dr} \\ &= \frac{R A_c C}{10 v} \frac{10 \ln\left(\frac{2}{1 + 0.1a}\right) + 11.5}{100 - a}. \end{aligned}$$

⁶IAEA CRP Report of the Modeling Group (Draft Final Report, version 3), Appendix 3.

⁷These estimates of doses from contamination at stops assume that the downwind direction is toward populations on the same side of the road as that on which the stops occur.

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If, on the other hand, the closest exposed individual is 10 m or more from the transport, *i.e.* 10 m \neq $a \neq$ 100 m, then

$$\bar{C}_{d,10-100} = \frac{R A_C C}{10v} \left[\frac{\int_{r=a}^{100} \frac{dr}{0.2r}}{\int_{r=a}^{100} dr} \right] = \frac{R A_C C}{10v} \left[\frac{5 \ln r \Big|_{r=a}^{100}}{r \Big|_{r=a}^{100}} \right] = \frac{R A_C C}{10v} \left[\frac{5 \ln\left(\frac{100}{a}\right)}{100 - a} \right].$$

The average CEDE in the proximal exposure region, then, is given by one of two expressions, either

$$\bar{E}_p = \frac{R A_C C}{10v} f T B_{inh} R_{10} \left[\frac{10 \ln\left(\frac{2}{1 + 0.1a}\right) + 11.5}{100 - a} \right], \text{ for } a < 10,$$

or

$$\bar{E}_p = \frac{R A_C C}{10v} f T B_{inh} R_{10} \left[\frac{5 \ln\left(\frac{100}{a}\right)}{100 - a} \right], \text{ for } 10 \leq a \leq 100,$$

Distal Dose

To estimate an average airborne concentration at distances exceeding 100 m, for determining the distal dose, it is assumed that $f_r = 0.2 r$. However, f_r is constrained to take on a constant value, ($f_r = 0.2 r_b$), beyond the downwind distance r_b where the height of the cross-sectional area that f_r defines becomes equal to the height h_b of the mixing layer (planetary boundary layer). This constraint addresses the situation in a thermal inversion, when warm air aloft prevents vertical diffusion and curtails dilution of airborne contaminants.

The cross-sectional area defined by the quantity Q is assumed to be a square with its bottom edge at ground level, so that r_b is determined from

$$Q = 10 A f_r = 10 A(0.2 r_b) = h_b^2,$$

giving

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$$r_b = \frac{h_b^2}{2A} .$$

Note that $r_b > 800$ m (and f_r is, therefore, unconstrained by the mixing layer in our analysis) unless the height of the mixing layer is less than about 456 m. The average airborne concentration in the region from 100 m to 800 m from the transport is then given, when $r_b < 800$ m ($h_b < 456$ m), by

$$\begin{aligned} \bar{C}_{d,100-800} &= \frac{R A_C C}{10v} \left[\frac{\int_{r=100}^{800} \frac{dr}{f_r}}{\int_{r=100}^{800} dr} \right] = \frac{R A_C C}{10v r} \bigg|_{r=100}^{800} \left[\int_{r=100}^{r_b} \frac{dr}{0.2r} + \int_{r=r_b}^{800} \frac{dr}{0.2r_b} \right] \\ &= \frac{R A_C C}{10v (800 - 100)} \left[5 \ln r \bigg|_{r=100}^{r_b} + \frac{5r}{r_b} \bigg|_{r=r_b}^{800} \right] = \frac{R A_C C}{7000v} \left[5 \ln \left(\frac{r_b}{100} \right) + \frac{5(800 - r_b)}{r_b} \right] \\ &= \frac{R A_C C}{7000v} \left[5 \ln \left(\frac{h_b^2}{200A} \right) + \frac{10A}{h_b^2} \left(800 - \frac{h_b^2}{2A} \right) \right] , \end{aligned}$$

and, when $r_b \geq 800$ m ($h_b \geq 456$ m), by

$$\begin{aligned} \bar{C}_{d,100-800} &= \frac{R A_C C}{10v} \left[\frac{\int_{r=100}^{800} \frac{dr}{f_r}}{\int_{r=100}^{800} dr} \right] = \frac{R A_C C}{10v r} \bigg|_{r=100}^{800} \left[\int_{r=100}^{r_b} \frac{dr}{0.2r} \right] \\ &= \frac{R A_C C}{7000v} \left[5 \ln \left(\frac{h_b^2}{200A} \right) \right] . \end{aligned}$$

A graphical representation of the activity concentration with distance from the cask for a non-fixed surface contamination level of 1 Bq cm⁻², mixing layer at 300 m, and representative values of the other parameters from IAEA guidance is shown in Figure E-2.

One of two equations is then used to determine the average CEDE in the distal exposure region, either

$$\bar{E}_d = \frac{R A_C C}{7000v} f T B_{inh} R_{10} \left[5 \ln \left(\frac{h_b^2}{200A} \right) + \frac{10A}{h_b^2} \left(800 - \frac{h_b^2}{2A} \right) \right] , \text{ for } h_b \leq 456 \text{ m},$$

or

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$$\bar{E}_d = \frac{R A_c C}{7000v} f T B_{inh} R_{10} \left[5 \ln \left(\frac{h_b^2}{200 A} \right) \right], \text{ for } h_b > 456 \text{ m.}$$

Total Population Dose

Population dose is the product of the number of exposed individuals and the average dose, summed over each region of exposure,

$$E_{Pop} = \sum_i n_i \bar{E}_i .$$

The number of exposed individuals in the i th region is the product of population density (m^{-2}) and area (m^2) subtended by the plume of airborne contamination. The contamination is assumed to disperse into a cross-sectional area defined as the product ($10 A f_r$), and with the simplifying assumption that this area is a square with one edge, having length $\sqrt{10 A f_r}$, at ground level. The dispersion footprint of the plume of contamination is shown in Figures E-3 and E-4. Figure E-3 shows the dispersion footprint at distances between 10 m and 800 m downwind from the source of contamination, corresponding to the region where $f_r = 0.2 r$. Figure E-4 shows the dispersion footprint between 5 m and 10 m downwind, where $f_r = (1 + 0.1 r)$.

The area subtended by the plume of contamination at distance r from the cask is the integral of the length of cross-sectional area at ground level,

$$\alpha_r = \int_{r=a}^{r_{max}} \sqrt{10 A f_r} dr .$$

This integral solves to give

$$\alpha_r = \frac{2\sqrt{2A}}{3} (r_{max}^{3/2} - a^{3/2}) , \text{ for } a \geq 10 \text{ m} ,$$

and

$$\alpha_r = \frac{2\sqrt{A}}{3} (r_{max}^{3/2} - a^{3/2}) + \sqrt{10A} (r_{max} - a) , \text{ for } a < 10 \text{ m} ,$$

Dispersion in the proximal area, then (since $r_{max} = 100 \text{ m}$) leaves a footprint of

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$$\alpha_{r,p} = \frac{2\sqrt{2A}}{3} (100^{3/2} - 10^{3/2}) + \frac{2\sqrt{A}}{3} (10^{3/2} - a^{3/2}) + (10 - a)\sqrt{10A}$$

for $a < 10$ m, and

$$\alpha_{r,p} = \frac{2\sqrt{2A}}{3} (100^{3/2} - a^{3/2})$$

for $a \geq 10$ m.

Both lateral and vertical dispersion are assumed to cease when a thermal inversion exists at the point where the dispersion height equals the height of the mixing layer, *i.e.* when $r_b < 800$ m ($h_b < 456$ m). The area subtended by the plume of airborne contamination constrained in this way in the distal region is rectangular, with width h_b and length ($r_{\max} - r_b$). The total area subtended by the plume of contamination in the distal region is given, therefore, by

$$\begin{aligned} \alpha_{r,d} &= \frac{2\sqrt{2A}}{3} (r_b^{3/2} - a^{3/2}) + h_b (r_{\max} - r_b) \\ &= \frac{2\sqrt{2A}}{3} \left[\left(\frac{h_b^2}{2A} \right)^{3/2} - 100^{3/2} \right] + h_b \left(800 - \frac{h_b^2}{2A} \right), \end{aligned}$$

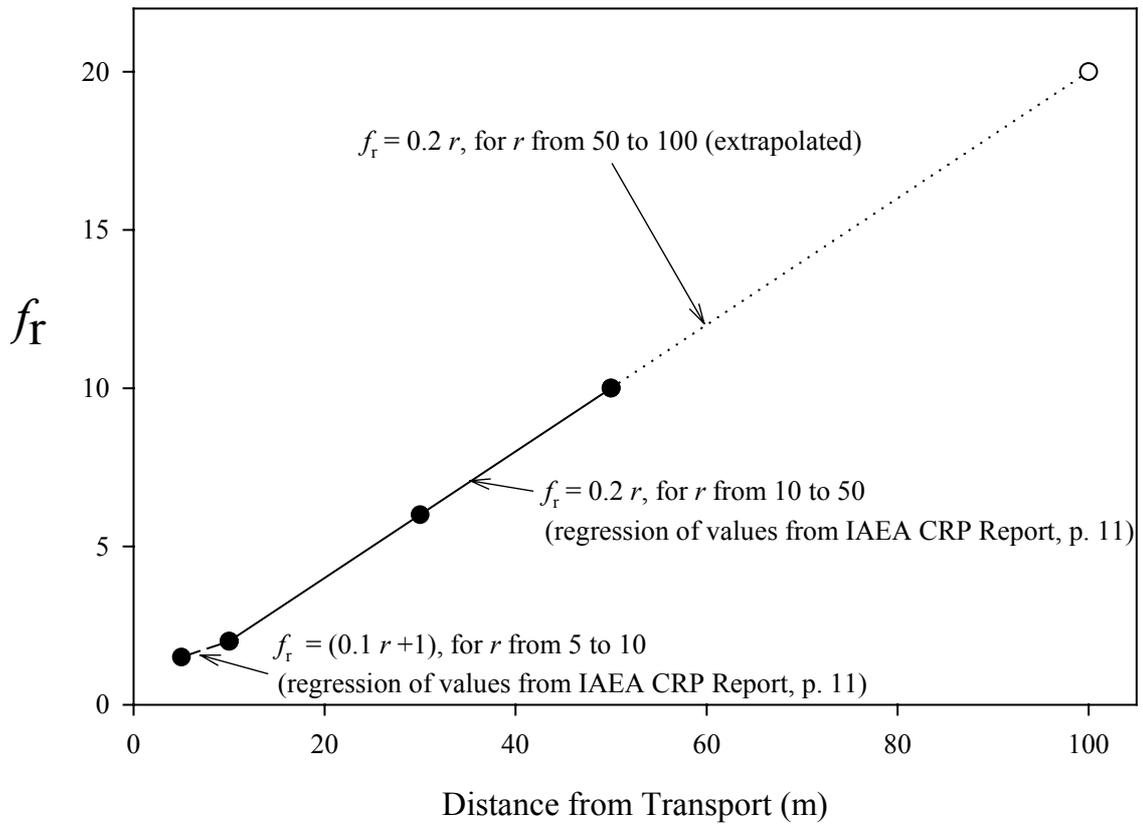
when an inversion exists, *i.e.* $r_b < 800$ m ($h_b < 456$ m), and by

$$\alpha_{r,d} = \frac{2\sqrt{2A}}{3} (r_{\max}^{3/2} - a^{3/2}) = \frac{2\sqrt{2A}}{3} (800^{3/2} - 100^{3/2})$$

when $r_b \geq 800$ m ($h_b \geq 456$ m).

FIGURE E-1

Values of f_r for Distances of 5 m to 100 m
from the Transport



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FIGURE E-2

Atmospheric Activity Concentration with Distance from the Source
for a 300-m Mixing Layer
($A_c = 1 \text{ Bq cm}^{-2}$)

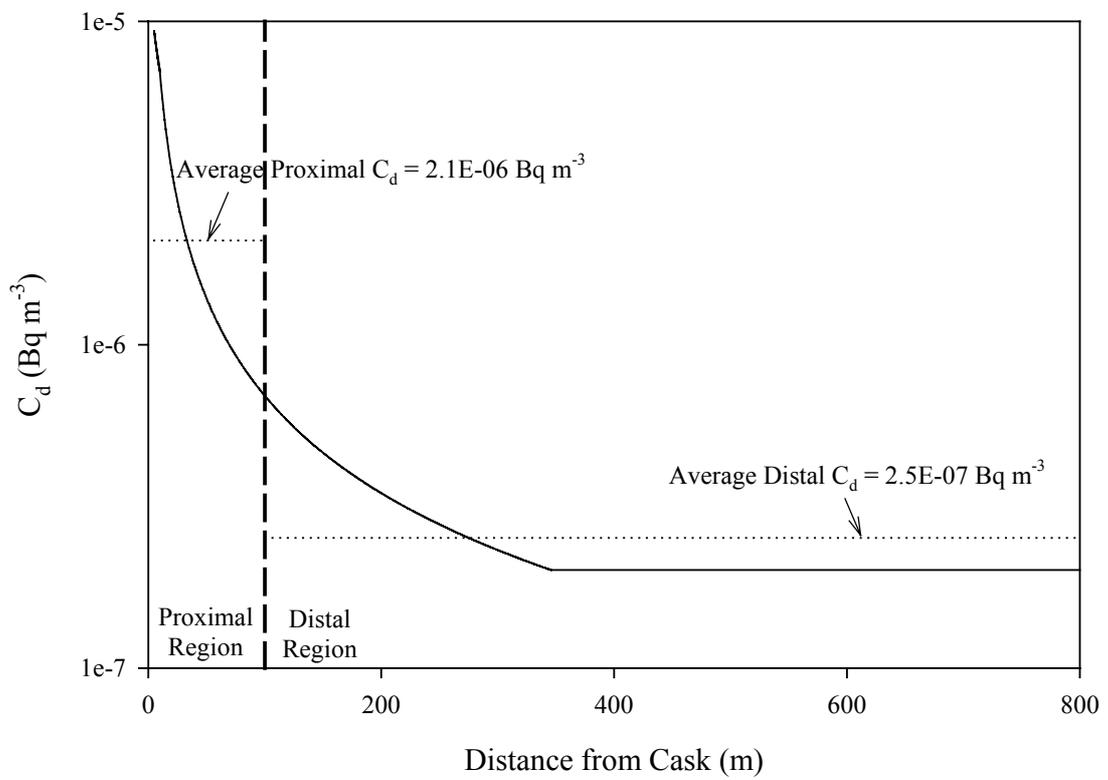
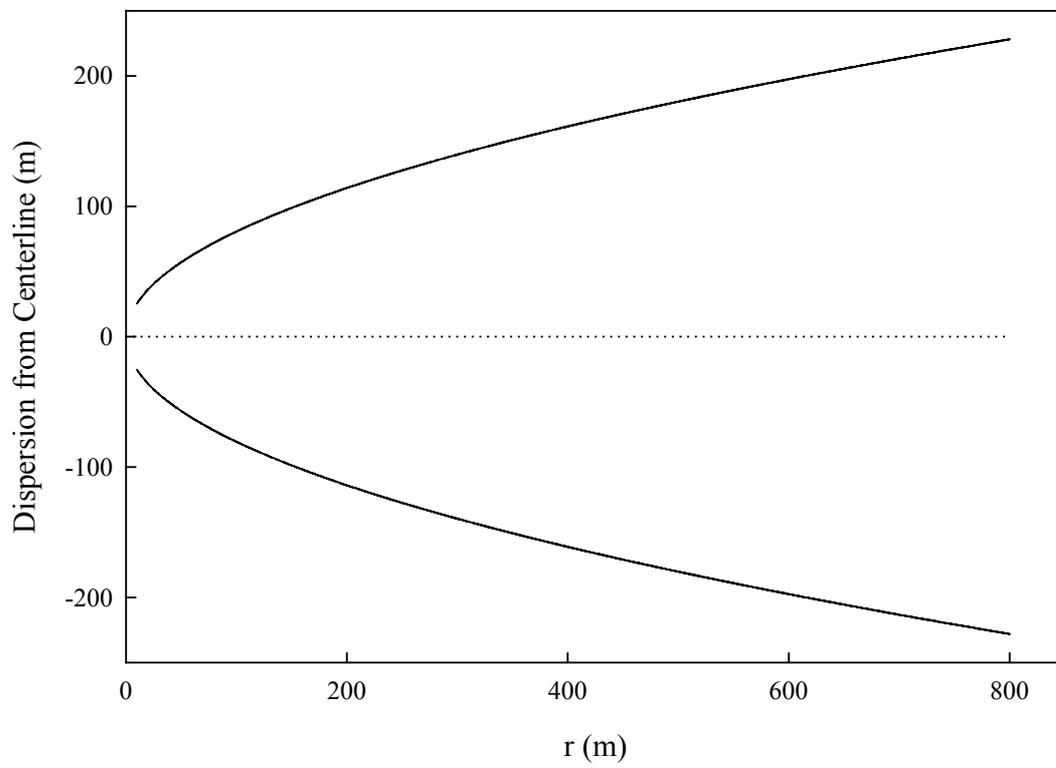


FIGURE E-3

Ground Footprint of Airborne Contamination
(10 m to 800 m from Cask, No Inversion)



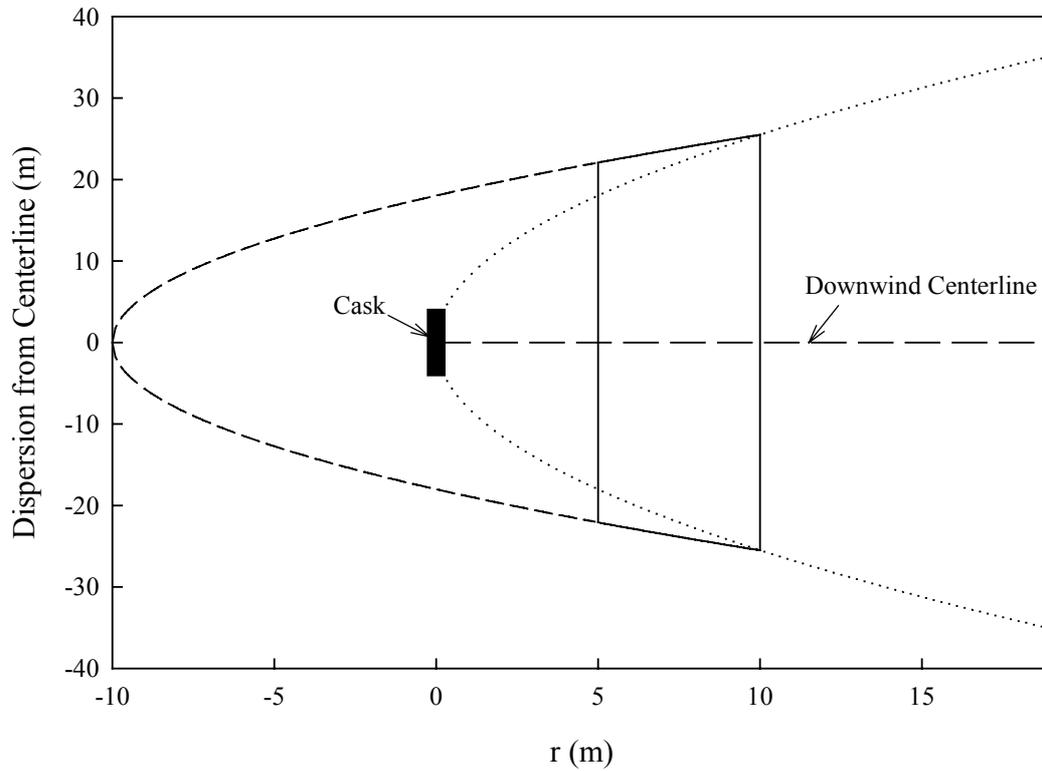
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FIGURE E-4

Notes:

Ground Footprint of Airborne Contamination
5 m to 10 m from Cask (Dashed Line)

Area subtended by the plume of contamination is bounded by the solid lines. The footprint for distances exceeding 10 m from the cask is shown (dotted line) for comparison.



Appendix F - External Exposures to Members of the Public

Maximum Exposed Person

The maximum exposed person from the on-link population must be determined from persons in another vehicle passing or meeting the shipment in an adjacent lane, or immediately following the shipment in the same lane. The maximum exposed person from the off-link population is a stationary individual located beside the roadway immediately adjacent to the lane of a passing shipment.

Dose from Following a Transport at a Fixed Distance

The external dose E to a person following a transport at fixed distance d is simply the product of dose rate \dot{D} at that distance and the following time t . At the distances applicable to exposure to members of the public, the dose rate is related to the reference dose rate \dot{D}_0 by the inverse square of distance, so that

$$E = \dot{D}t = \dot{D}_0 t \left(\frac{d_0}{d} \right)^2$$

where d_0 is the distance at which \dot{D}_0 is determined.

Dose from a Passing Transport

The exposed person is standing unshielded at a fixed distance from the roadway. A cask with a surface contamination reference dose rate at 1 m (\dot{D}_0) passes the person at a fixed rate. The time-dependent distance from cask to person is given by

$$d^2 = a^2 + (rt)^2$$

where d is the distance from cask to person, a is the distance of the person from the roadway, r is the rate of travel of the cask, and t is time. The instantaneous dose rate to the person, assuming $1/d^2$ dependence (appropriate for the distances in these scenarios), is

$$\dot{D}_t = \frac{\dot{D}_0}{d^2} = \frac{\dot{D}_0}{a^2 + (rt)^2} ,$$

and the total dose delivered by the passing cask is

$$E = \int_{t=-\infty}^{\infty} \dot{D}(t) dt = 2 \int_{t=0}^{\infty} \dot{D}(t) dt = 2 \int_{t=0}^{\infty} \frac{\dot{D}_0}{a^2 + (rt)^2} dt = \frac{2 \dot{D}_0}{r^2} \int_{t=0}^{\infty} \frac{dt}{\left(\frac{a}{r} \right)^2 + t^2} ,$$

where $t=0$ is the time when the cask-to-person distance is the minimum distance, a . The integral is of the form

$$\int \frac{dx}{b^2 + x^2} = \frac{1}{b} \tan^{-1} \frac{x}{b} ,$$

which yields a solution for the total dose,

$$E = \frac{2 \dot{D}_0}{ra} \tan^{-1} \left(\frac{rt}{a} \right) \Big|_{t=0}^{\infty} = \frac{\pi \dot{D}_0}{ra} .$$

The minimum distance a for a person standing by the roadside depends on the type of highway. For Interstate highways, $a = 30$ m; and for other highways, $a = 27$ m.

This same expression can be used to determine the dose to on-link individuals in vehicles passing or meeting the transport. The value of r , in this case, is the relative velocity between the cask and the passenger vehicle. The minimum distance a is taken as the distance between centerlines of the lane of travel of the cask and that of the passenger vehicle ($a = 4$ m for passing vehicles and for vehicles meeting the transport on other highways; $a = 23$ m for vehicles meeting the transport on multi-lane divided highways).

External Exposures - Collective Dose

Collective doses from external exposures to on-link populations (passengers in vehicles) in lanes #2, #3, and #4 are estimated using the same expression as for dose from a passing shipment and the number of persons affected. Doses to passengers in lane #1 are estimated using the distance-corrected dose rate to the first 100 vehicles behind the shipment. An 'effective distance' (corresponding to the average dose rate) can be used for all 100 vehicles, as described below, to simplify this calculation. The time of exposure is the duration of the shipment.

Collective doses from external exposures to off-link populations can be estimated using the same expression as for dose from a passing shipment if the entire population in contiguous exposed areas is assumed to be concentrated at a distance from the roadway receiving a dose rate equal to the average dose rate for the dispersed population. The population thus concentrated is in an annulus around the cask during stops, and is in a line along the roadway when the cask is in motion.

Average Distance of the Exposed Population from the Transport

The population living near a highway where spent-fuel casks are transported is assumed in this analysis to be uniformly distributed within a strip with its nearest boundary a distance 'a' from the roadway and its furthest boundary a distance 'b' from the roadway. A cask on the roadway delivers a dose rate to an individual in this strip given by

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$$\dot{D}(r) = \dot{D}_0 \left(\frac{d^2}{r^2} \right) .$$

where \dot{D}_0 is the reference dose rate from the surface contamination at distance d , and r is the individual's distance from the cask ($a \neq r \neq b$). The average population dose rate is given by

$$\begin{aligned} \overline{D}_s &= \frac{\int_{r=a}^b \dot{D}(r) \, dr}{\int_{r=a}^b dr} = \frac{\int_{r=a}^b \dot{D}_0 \left(\frac{d^2}{r^2} \right) \, dr}{\int_{r=a}^b dr} = \frac{\dot{D}_0 d^2 \int_{r=a}^b \left(\frac{dr}{r^2} \right)}{\int_{r=a}^b dr} \\ &= \frac{\dot{D}_0 d^2 \left(-\frac{1}{r} \right) \Big|_{r=a}^b}{r \Big|_{r=a}} = \frac{\dot{D}_0 d^2 \left(\frac{1}{a} - \frac{1}{b} \right)}{b - a} \end{aligned}$$

The average population dose rate corresponds to the dose rate delivered by a cask with the reference dose rate, but delivered at a distance given by

$$r_{\text{eff}} = \sqrt{\left(\frac{\frac{1}{a} - \frac{1}{b}}{b - a} \right)^{-1}} .$$

This 'effective distance' is used in estimating population doses from a shipment on the highway. If the reference distance is 1 m, then the expression for total unit collective dose delivered by the cask in motion along the entire length of its route is found by substituting r_{eff} for r in the equation. The unit collective dose for a stopped transport is the product of dose rate at r_{eff} and the time interval that the transport is stopped. Values for a and b depend on the location of the population segment with respect to the transport and on the type of roadway, as shown in the table below.

Values of a and b for Estimating Collective Doses from External Exposures			
Highway	Population Segment	a (m)	b (m)
State	Nearest to Transport	29	798
State	Opposite from Transport	33	802

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Interstate	Nearest to Transport	32	786.5
Interstate	Opposite from Transport	59	813.5

A spreadsheet was developed to apply the above approaches to calculate the individual and collective doses reported in Section 5 of this report.

ⁱ Notes on Certain Aspect of the Regulations, Safety Series No. 7, International Atomic Energy Agency, Vienna, Austria, 1961.

ⁱⁱ Report of Committee 2 on Permissible Dose from Internal Radiation, International Commission on Radiological Protection, Pergamon Press, Oxford, 1959.

ⁱⁱⁱ Dose Coefficients for the Intake of Radionuclides by Worker, ICRP Publication 68, International Commission on Radiological Protection, Pergamon Press, Oxford, 1994.

^{iv} W.E. Kennedy, Jr., E.C. Watson, D.W. Murphy, B.J. Harrer, R. Harty, and J.M. Aldrich, "A Review of Removable Surface Contamination on Radioactive Materials Transport Container," NUREG/CR-1858, PNL-3666, Pacific Northwest Laboratory, Richland WA, 1981.

^v J.H. Mairs, G.A. Smith, and K.B. Shaw, "Derived Limits for Surface Contamination of Transport Packages," NRPB Contract 12485, National Radiological Protection Board, Chilton, UK, 1987.

^{vi} International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, International Atomic Energy Agency, Vienna, Austria, 1996.

^{vii} Mason, M., et al, "Factors Affecting Surface Decontamination of Spent-Fuel Casks", Electric Power Research Institute, EPRI NP-3906 (February 1985)

^{viii} Private communication, Operations personnel at a U.S. light water power reactor to J. Cook (Nuclear Regulatory Commission), August 10, 2001.

^{ix} K. J. Schneider, et al., "Analysis of Radiation Doses from Operation of Postulated Commercial Spent Fuel Transportation Systems", DOE-CH/TOP-001, (November 1987).

^x Harvey, M., et al, "Principles and Methods for Establishing Concentrations and Quantities (Exemption Values) Below which Reporting is not Required in the European Directive", Radiation Protection – 65, Document XI-028/93, Commission of the European Communities, 1993.

^{xi} Kocher, D.C. and Eckerman, K.F., "Electron dose-rate conversion factors for external exposure of the skin from uniformly deposited activity on the body surface", *Health Physics* 53:135-141, 1987.

^{xii} Little, M.P., et al, "Assessment of Skin Doses", National Radiological Protection Board, Vol. 8, No. 3, 1997

^{xiii} Kocher, D.C. and Eckerman, K.F., "Electron dose-rate conversion factors for external exposure of the skin from uniformly deposited activity on the body surface", *Health Physics* 53:135-141, 1987.

^{xiv} Neuhauser, K.S., et al, "RADTRAN 5 Technical Manual", Sandia National Laboratories, SAND2000-1256, May 2000.

^{xv} Johnson, P.E., and Michelhaugh, R.D., "Transportation Routing Analysis Geographic Information System (WebTRAGIS) User's Manual, Oak Ridge National Laboratory, ORNL/TM-2000/86.

^{xvi} Degrange, J.P., et al, "Analysis of the Doses Associated with the Spent Fuel Shipments from the French NPPS: Are They ALARA?" Proceedings of the 3rd ISOE European Workshop on Occupational Exposure Management at NPPS, Portoroz, Slovenia, April 2002, available online at:

<http://isoe.cepn.asso.fr/programPortor.html>